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THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XVIII.—No. 442.

SELF-REGULATING DYNAMOS.

THE recent discussion in a contemporary between the Reviewer of "Dynamo-Electric Machinery" and the Author of that work once more impresses us with the necessity for clear definition. The discussion had special reference to self-regulating dynamos and motors and arose out of a statement on the part of the Reviewer that no machine of which the magnetic field was partially supplied from an external source could have a critical speed. The Reviewer gave as his definition of critical speed that at which for a particular resistance in circuit the dynamo would just magnetise itself, while the Author declared that the correct meaning of critical speed was that at which the dynamo or motor became self-regulating.

Manifestly, as was pointed out at the close of the discussion, but one of these definitions can be right. Disregarding the arguments which were employed in a dispute which was not ours, it is our intention to make an independent investigation with a view to discover which definition is the correct one, and we shall probably be able also to see how the confusion has arisen.

In the paper read before the Society of Telegraph-Engineers by Profs. Ayrton and Perry on "Electro-Motors and their Government,"* the meaning which is intended to be conveyed by the term "critical speed" is clearly defined. They say, page 307, . . . "but even a slight increase in the speed of a dynamo, the circuit of which remains unaltered, will also produce the same effect if the speed be the critical speed for the resistance through which the dynamo is sending a current, because this critical speed is that below which but a small current is sent by the dynamo machine, and above which a great current is sent by the dynamo machine—that is to say, below the critical speed for any particular resistance the dynamo acts very feebly while above that speed it acts as a powerful dynamo machine." In a letter addressed to the *Electrician* in November of last year Prof. Ayrton remarked that their experiments had led them theoretically to the conclusion that for every speed of a dynamo, there is a critical value of the total resistance which, if exceeded, practically results in no current being generated: and in their paper on electro-motors they are careful to mention that the idea of a critical speed had been foreseen by Sir Wm. Thomson some years before it had occurred to them. In a paper read before the Institute of Mechanical Engineers in 1880,† Dr. J. Hopkinson had used the term *critical current* to express the particular current at which any

given dynamo began to excite itself; and it was a study of the relation between the exciting speed and resistance which led M. Deprez to remark that by means of the characteristic we could see how there was a given resistance at which the excitement was nil and at which the machine ceased to act.*

Now, in the above utterances, there is no ambiguity of expression. The meaning of critical speed is quite clear, and the term had a distinct signification perfectly understood by electricians before self-regulating dynamos were at work in this country. As judged by their writings, there was obviously in the minds of the scientists quoted but one idea of critical speed, and expression was given to that idea in the statement that the critical speed was that at which for a given resistance in circuit the machine would only just give a current or magnetise itself.

Denoting current by abscissæ and E.M.F. by ordinates; if a straight line be drawn from O such that the tangent of the angle it makes with the axis of abscissæ represents the total resistance in circuit, the speed is critical when the line so drawn coincides with the straight part of the characteristic. A machine under such circumstances is extremely unstable, for if the resistance is but increased by a small amount no current will flow, while if it is diminished slightly the current will be excessive. Running under these conditions the speed is said to be critical for this resistance in circuit, also for this speed the resistance is said to be critical, and lastly there is a critical current for all speeds below which the machine will not work.

The statement so often made that the constant potential dynamo regulates at the critical speed for the combined resistance of the armature and series coil is found in practice to be untrue, and such a conception can only be due to a misunderstanding of the conditions on which in this class of machine regulation depends. Although no machines have been designed in which the mass of iron is so excessive as to cause the characteristic to be approximately a straight line for the whole of the excitement supplied by the two coils on the magnets, yet most of the mathematical work done in connection with regulating dynamos has been based on the assumption of a rectilinear characteristic.

Our readers will remember that the constant potential machine of Deprez had two coils wound on its fields, one separately excited by an auxiliary dynamo and the other in series with the armature and external part of the circuit. Let us keep this machine in mind, losing sight for a time of the wholly self-exciting compound machine with its shunt and series coils now so familiar to us. Here is the argument of Deprez, of Ayrton and Perry and of Thompson. We have a series dynamo with a large quantity of iron in it. We short circuit the machine and run it at a speed such that it just excites itself. This is the critical speed. An auxiliary coil is wound on the magnets, and this coil is separately excited while the machine is run

* Journal of the Society of Telegraph-Engineers and Electricians, No. 49, Vol. XII., 1883.

† Proceedings, 1880, page 266.

* "Electrical Transmission and Distribution of Energy," by M. Deprez, *ELECTRICAL REVIEW*, March 22nd, 1884.

at the speed previously determined. The machine, say these writers, will now regulate, giving a constant difference of potential at the terminals, which may be increased or diminished by increasing or diminishing the excitement furnished by the auxiliary coils. Such a machine, partly excited by a separate dynamo, has obviously no critical speed to correspond with our definition, since it will give a current at any speed and with any resistance in circuit. It is true that in this hypothetical machine, where we have assumed the characteristic to be rectilinear, the speed at which the machine regulates is *coincident* with the critical speed, but this cannot possibly justify the statement that critical speed is the same thing as regulating speed, and the coincidence in this case depends entirely upon the assumption above made, for in practice no such agreement is to be found between the two speeds. Because a particular machine happens to regulate at a velocity which is critical for the resistance of the armature and series coil, it does not follow that the correct definition of critical velocity is that at which any machine will regulate. The terms critical speed and regulating speed convey ideas essentially different, about which no confusion need exist, and only dynamos which are wholly self-exciting can have a critical speed.

So much for the hypothesis of the rectilinear characteristic, but let us examine the evidence of practice on this point. In the second edition of "Dynamo-Electric Machinery," page 97, with reference to machines constructed as described, we read: "*M. Deprez has further shown that this velocity can be deduced from experiment and that when the critical velocity has once been determined the machine can be adjusted to work at any desired E.M.F. by varying the strength of the separately excited current to the desired degree.*" Now this conclusion is based not only on the fact that we work on a portion of the characteristic which near the origin is, approximately straight, but that this portion can be prolonged to excessive limits so that the E.M.F. added to the circuit by the series wire is independent of the amount of excitement furnished by the auxiliary coil. In practice this is never the case, and we question if a machine could be built which, fulfilling this condition, would regulate at its critical speed; at any rate, it is uniformly found that the regulating speed of a machine constructed in accordance with Deprez's views is always greater than the critical speed for the resistance of the armature and series coil, because of the impoverished effect of the series wire due to partial saturation by the auxiliary coil. As a consequence of this when the excitement is increased so as to produce a higher E.M.F. the speed must be increased in some definite relation to the separate excitation. In confirmation of this fact, it has been shown that the compound dynamo regulates with different potentials at very different speeds, the increased speed compensating for the diminished magnetism furnished by the series wire when the initial magnetism supplied by the shunt is high.

In investigating the action of regulating machines the effect of the series wire being modified as the initial magnetism undergoes changes seems to have been lost sight of. In the paper of Ayrtton and Perry before referred to this consideration is clearly omitted, for in specifying the conditions of governing in motors they "*conclude that the resistance of the armature and demagnetising coil combined is such that it is the critical resistance of the dynamo part of the combination for the speed at which it is desired the motor shall always run, no matter what amount of work it may be doing.*" In other words the meaning is, that the velocity of the motor when working as a dynamo with the shunt coil inactive, which is just sufficient to send a current through itself, is the velocity at which it will regulate with the shunt coil in action. Without saying whether motors constructed on this plan will or will not be efficient, we think the omission referred to detracts seriously from the value of the general reasoning, since their constant potential compound motor excited by a shunt coil can have no critical speed, and a variation in velocity cannot, therefore, cause the dynamo part to act

as a strong or weak brake above or below a fixed speed. As far as we can make out considerations regarding the relation between the magnetising powers of the two coils have been neglected in Deprez's work, and Thompson in his "Dynamo-Electric Machinery," excludes them in the mathematical treatment. This oversight is the cause of any confusion which may have arisen. The value of the series wire in adding to the E.M.F. of the machine has been supposed by these writers to be independent of the magnetism provided by the auxiliary coils. Knowing that, on the assumption of a rectilinear characteristic, the speed of regulation was coincident with the critical speed it was easy to imagine them synonymous terms. To call the regulating speed the critical speed when no relation existed between them was but the one step farther necessary to make the confusion complete.

In accordance with our definition, in a compound dynamo which is completely self-exciting and which has a shunt coil taking the place of Deprez's auxiliary coil, the speed, when the external circuit is open, is critical when it is just sufficient to cause the shunt coil to excite the machine. There is in the compound dynamo no one particular speed at which the machine will be self-regulating, since at several different speeds, although with different potentials, the machine regulates equally well for the whole range of its current. While in the past the notion that the speed of regulation must always be of equal value to the critical speed may have palliated the confusion of terms, now that the action of these machines is more fully understood, it would, we think, be wise to expunge any misconceptions which can be traced to our former ignorance.

HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

V.—SERIES MACHINES.—(Continued.)

HAVING found, as described, that the cores are not too large or too small, and having found the proper value of the diameter of the wire from the allowable fall of potential and the ampère turns, and also having guarded against heating, there remains only to provide that the last layer may be wound full, for the sake of appearance. This may be done in the case in which there are only a few turns more or less than what would be required to make it full, by simply winding it full and varying the speed slightly to compensate for this, if necessary. If, however, this difference is comparatively great, it is best to proceed as follows:—Calculate the number of turns which would come on the last incomplete layer, wind that number of turns on the next to the last layer, fill up the remaining space with cardboard, or the like, to the thickness of one layer, and wind the last layer full over all. Or it may be done by winding the odd number of turns in a coarse or open spiral in the next to the last layer, and then cover this with a sheet of stiff cardboard, over which wind the last layer full. This, however, is not as good as the first method, as the cardboard, if not very stiff, is apt to cave in.

Having made all the necessary calculations for the diameter of the wire, it is best to check the result by determining the loss of potential for the wire selected, and to compare this with the allowable loss of potential. To do this, calculate the corrected mean length of one winding l_m , in inches. The resistance will then be:

$$R = \frac{50 \cdot 13 \cdot w \cdot l_m \cdot \theta}{d^2},$$

then from Ohm's law and this equation, the fall of potential in the whole magnet circuit will be:

$$v = \frac{50 \cdot 13 \cdot (a \cdot w) \cdot l_m \cdot \theta}{d^2},$$

which for $\theta = 0.0162$ and a temperature of 70° Fahr. becomes :

$$v = \frac{.875 (a w) l_m}{d^2} = \frac{3.5 (a w) l_m}{4 d^2},$$

in which d is in mils and l_m is the corrected mean length in inches, of one winding.

If this gives a value much higher than that which was allowed, owing to the fact that the smaller gauge number wire nearest to the theoretical value obtained by the formula was taken, then if the difference is too great to be allowed, the next size larger may be taken, without necessitating any other change in dimensions.

If, when the machine is completed and is run on its proper circuit, it is desired to make the final accurate adjustment, it is only necessary to increase or diminish the speed by a few turns. This may be calculated from the final test by taking the speed proportional to the potential, provided the current strength was correct. If both the current and potential are slightly incorrect, alter the external resistance until the current is correct, then measure the potential and proceed as before. Care should be taken that the machine is warm throughout before making the measurements. These final adjustments will, if the machine is properly calculated, be very slight in most cases, and can, therefore, generally be dispensed with.

If it is desired to regulate the machine to supply the same current with different potentials, that is, to run a varying number of arc lamps, place the adjustable resistance in multiple arc (as a shunt) with the magnet coils. This will shunt off some of the current from the magnets, and will enable one to regulate the magnetism and therefore adjust for different numbers of lamps.

If this is to be done, make the first test for both the maximum and minimum number of lamps, noting the ampere windings required in both cases. Calculate and complete the machine just as before from the larger of these two numbers of ampere turns. The current required in the magnets in the two cases will evidently be proportional to the ampere windings, for the number of windings is the same. This gives the current required in the magnets when the smallest number of lamps are run. Having calculated the resistance of the coils, it is easy to calculate what the adjustable resistance should be in order that the proper amount of current may be shunted off by it, for the currents will be approximately inversely as the resistance.

If the normal current of the machine is a and the ampere turns required in the two extreme cases are $(a w)$ and $(a' w)$ then the current required in the magnets for the small load is approximately

$$a' = \frac{(a' w)}{(a w)} a,$$

and if R is the total resistance of the coils and r the minimum adjustable resistance for the small load, then

$$r = \frac{a'}{a - a'} R.$$

The maximum adjustable resistance depends on whether the machine is to be regulated near its full load. If so, the maximum resistance can be calculated similarly to the above.

As the winding of the magnets is entirely independent of this resistance, a less troublesome and sufficiently accurate method of determining this resistance is to run the finished machine from its full load down to a short circuit, and, every time the load is reduced, adjusting any convenient resistance which shunts the magnets, so as to get the proper current in the external circuit. Measure these resistances for each case and calculate the adjustable resistance wire from this, taking care to proportion the diameter of the resistance wires so that they will not heat too much, and at the same time not require too much wire. The current going through the rheostat can be readily calculated for each case from the resistance of the magnets and the resistance of the shunt rheostat.

To illustrate the winding of a series machine according to the method described in this article, let us assume the following data :—

An arc light, series-wound machine is to be built for a 10 ampere current at 1,000 volts, or about 20—23 lamps. Speed, 1,200 revolutions.

The armature was constructed and a trial frame built. Upon running the machine with four temporary coils of 250 windings each, it was found to require an exciting current of 40 amperes to bring the current of the machine up to 10 amperes and $1,000 + 2.5$ per cent. of $1,000 = 1,025$ volts. This gives $250 \times 4 \times 40 = 40,000 = (a w)$ as a measure of the magnetism.

The oval cast iron cores were $8\frac{1}{2} \times 2\frac{3}{4}$ inches. The assumed thickness of coil is $\frac{1}{3}$ of $2\frac{3}{4}$, or about 1 inch. The periphery of core was found to be 18.8 inches. This gives from our formula* the mean length of one winding 22.1 inches. From the formula for the diameter of the wire for the magnets,

$$d = \sqrt{\frac{.875 (a w) l_m}{v}},$$

taking the allowable fall of potential at 25 volts, and assuming a factor of safety of 5 per cent., making $v = 95$ per cent. of 25 = 23.8 volts, the diameter will be

$$d = 181 \text{ mils.}$$

This is about No. 5 B and S. The heating will not be too great, for, from our constant for the density of current, a No. 9 wire will stand the current very well.

No. 5 wire was found to have an outside diameter of 220 mils. The length of core being 10 inches, there will be 45 windings per layer. As there must be 40,000 ampere windings, and being a series machine, and the current in the magnets being 10 amperes, there will be 4,000 windings, or 1,000 per magnet, or 22 layers, making a thickness of coil of $4\frac{1}{2}$ inches, as compared with our assumed thickness of 1 inch. This apparently absurd result shows that the magnets are very much too small, and that it would hardly be possible to finish the machine for such a large load. This might have been seen from the magnetic curve, but for the sake of illustration the calculations were also made.

The figures obtained will, however, not only show us what load this machine will carry, but will also enable us to calculate about what the size of the magnets should be for another machine which will give 1,000 volts.

To determine the first, let a, b , fig. 2 (see p. 412, May 7th), be the curve of magnetisation for this machine, obtained as described in the first part of these articles. It will be seen from this curve that the magnets are saturated at about 18,000 ampere turns, and unless it is intended to over-saturate the cores to obtain greater steadiness in the current, this will be the maximum magnetism which ought to be used. Dropping perpendiculars from b and d , the distance, o, e , will represent 1,025 volts, and o, f , the greatest number of volts which the machine will give if not over-saturated, provided that the required number of ampere windings will not make the coils too large. This distance, o, f , measured by the same scale, was found to be about 880 volts.

Calculating the diameter, d , again for 18,000 ampere turns, and an allowable loss of potential of 2.5 per cent. gives

$$d = 128.4 \text{ mils.}$$

This is almost exactly No. 8 B. and S. This will be found to be large enough not to heat too much. Its external diameter is about 158 mils. This gives 63 windings per layer, and about 7 layers, making a thickness of coil of 1.1 inches. This is about the assumed thickness of 1 inch, and shows that the machine is properly proportioned.

To check the result, calculate the fall of potential with a No. 8 wire and a thickness of 1.1 inch. This gives from our formula

* See ELECTRICAL REVIEW, March 19th.

$$v = \frac{.875 (a w) l_m}{d^2} = 21.3 \text{ volts.}$$

This is inside of the limit of 22 volts, showing the calculations to be correct.

It is evident that another armature with more turns of wire might be used with the same frame, thus obtaining a higher potential with the same magnetisation, or the same potential with less magnetisation. This depends upon the nature of the armature used in the test, and belongs to the subject of armatures; it cannot therefore be discussed here. In this article it is assumed that the armature has been determined.

Let us now determine from the above test about what the size of the magnets should be for a new machine with the same armature, but giving the full potential of 1,025 volts, which is what it was originally intended for.

From the point, *d*, fig. 2, and from the size of the core, we can determine the saturation coefficient, or the allowable density of magnetisation for this particular quality of iron. As there are necessary for saturation 18,000 ampère turns, and as there are four magnets, if we divide one-fourth of this by the number of square inches in the cross-section of the core, viz., 18., it will give the allowable density or saturation coefficient. This gives 250 ampère windings per square inch. The cross-section of the new magnets must therefore be such that the density of magnetisation, as determined from the new number of ampère turns, does not exceed 250 per square inch.

To determine the ampère turns of the new magnets, prolong the part of the curve, *a, d*, fig. 2, until it intersects the line *b, e*, at a point, *c*; then *c, e*, will represent the magnetism required for 1,025 volts with the old magnets, if they were not over-saturated, for *b, e*, represents the magnetism required for 1,025 volts with the old machine in which the magnets are over-saturated.

Now from the point, *c*, it is seen that the distance, *c, e*, represents about 22,650 ampère turns. *d, f*, the allowable magnetisation for the small cores, is 18,000. Calling this (*a w'*) and *c, e*, the former (*a w*), while the required number of ampère windings is represented by (*a w*), then, from the formula, the value of (*a w*) is

$$a w = \sqrt[3]{(a w')^2 (a w'') - 21,000}.$$

This makes the new cross-section

$$\frac{21,000}{4 \times 250} = 21 \text{ square inches.}$$

The dimensions of the oval cores are, therefore, about 3 × 9 inches. The diameter of the wire will be, assuming a thickness of coil of about 1 inch,

$$d = 134 \text{ mils,}$$

or about No. 8 B. and S. This will not heat too much, as it is larger than that given by the allowable density of current. No. 8 wire has an outside diameter of about 158 mils., therefore, there will be 7 layers for a thickness of about 1 inch. This gives

$$\frac{21,000}{4 \times 7} = 75 \text{ turns per layer,}$$

making the new cores 75 × 158 = 12 inches long.

To check the result, calculate the fall of potential from the formula, which gives

$$v = 26 \text{ volts,}$$

or only a trifle higher than what was assumed at the outset. This results from having chosen the next smaller size wire to that given by the formula.

Suppose the finished machine gave only 990 volts and 10 ampères, then the speed should be increased to

$$\frac{1,200 \times 1,000}{990} = 1,212 \text{ revolutions.}$$

In conclusion it may be necessary to state that the above figures are not taken from an actual case, as no

such machine was at the disposal of the writer at the time. They are merely to illustrate the method, and are not to be taken as sizes to build a machine by, though at the same time they are not far from those of actual machines.

SELF-INDUCTION.

IN any attempt at determining by experiment the amount of self-induction in a linear conductor in which an electric current is started, we can only do so by measuring the retardation which the current experiences. The gradual development of the current up to its full strength as depending upon a longer or shorter period of time is, as is well known, illustrated by a curve, similar to the last figure, in which *o, i*, represents the ordinate of the *full*, or as Prof. Hughes terms it, the stable current, and 01. 02. 03 0y the divisions of time (in hundredths, or any other convenient part of a second), which is allowed for the growth of the current.

By so varying our experiment that we allow the current a definitely longer or shorter time for its development before we either interrupt or reverse it, and setting off the strengths of current obtained on the respective time ordinates, we obtain the curve which illustrates the growth or development of the *initial* or, as Prof. Hughes terms it, variable current. It appears to me evident, therefore, that for the purpose of determining the relative values of self-induction in two different wires we must insure in both cases an equal number of interruptions or reversals to make the comparative results between the two wires reliable; we must give in each case the current equal times for its development. I must confess that I fail to understand how far Prof. Hughes insures a predetermined regularity in his interruptor.

Now, with regard to measuring the retardation in a primary current by means of the increased resistance, it seems to me most desirable, if not absolutely necessary for the purpose of getting definite and not merely comparative results, that the *interruptions or reversals in the wire or conductor under experiment should not extend to any other part of the circuit*. Your readers will remember that, when measuring the full (or stable) current Prof. Hughes employed the interruptor in the telephone wire to adjust the bridge; but when ascertaining the self-induction in the wire under experiment he put the interruptor in the main circuit, and so produced self-induction not only in the wire, *x*, but in every part of the circuit; and I question whether even the E.M.F. of the battery was not influenced by it. I cannot help thinking but what the results were more or less of a comparative nature; it was balancing the self-induction of *x* against not only the resistance but also against the self-induction of the German silver wire of the bridge. For the purpose of ascertaining the retardation or self-induction in terms of resistance, the interruptions should take place in *x* alone, and they should be of a predetermined time value. Of course the interruptions required in the telephone bridge wire are here not referred to.

I here beg to suggest for your readers' approbation a form and construction of apparatus which I believe will fulfil the conditions asked for. The chief requirements of such an apparatus are: an interruptor or reverser, which should be capable of being rotated at definite speeds by clockwork or other similar means, of which the number of interruptions or reversals per second can be definitely arranged; and since such interruptor introduces into the circuit a certain resistance it should revolve just the same whether the full (stable) or the initial (variable) current is measured.

In fig. 1, I show an arrangement for measuring the retardation (or self-induction) due to an *alternating* current in a long wire with the special object of using the same strength of current through a series of experiments—such as for example: ascertaining the self-

induction in wires of different diameters but of the same material. The current from the battery, B, passes through the galvanometer, G, the resistance box, R, thence to b_1 , through the conducting surfaces of the key, K, to a_1 , through the wire, x (under experiment), to a , by way of the key to b , from which a wire leads to the brush or spring of the current reverser, C, and

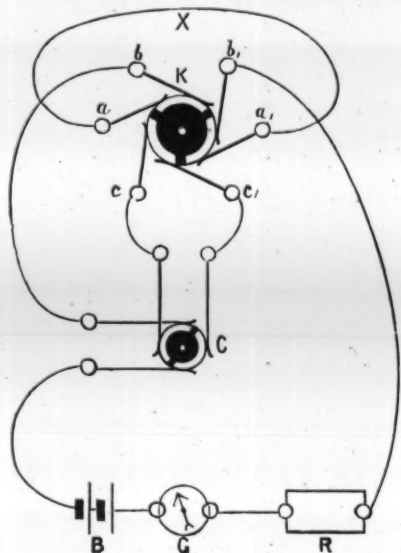


FIG. 1.

through this to c , then by way of the key to c_1 , back to the reverser, and so returns to the battery, B. It will be evident that the reversals (changes or alternations) of the current produced by the reverser, C, will take place only in the short wires and brushes, or springs, c, c_1 , whilst a steady full or stable current flows through the wire, x . Keeping the reverser at the same speed, and now turning the key, K, through 60° , into the position shown in fig. 2, the alternations will now take

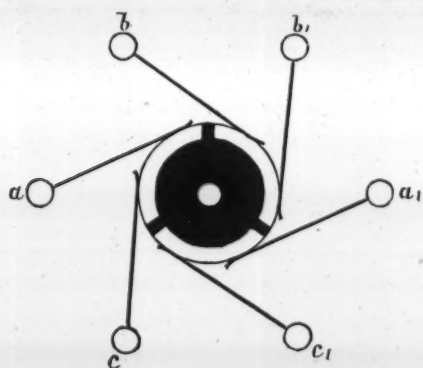


FIG. 2.

place in the wire, x . The increase of resistance due to self-induction in x will lessen the strength of the current, and so reduce the indications of G; but by reducing R we can bring the current to its previous strength. The changes in R together with the potentials between a and a_1 , with a stable and a variable current, will give us the comparative resistance of x at the speed with which the reverser is rotated. Varying this latter and always working with the same strength of current we can map out our curve.

For the purpose of interrupting the current in the wire, x , alone, and yet keeping a steady current in the rest of the circuit, I would suggest the following arrangement: instead of one, I would take two lengths of the same wire under investigation, and join these two lengths in a manner and by an interruptor as

shown in figs. 3 and 4, in which the current from the battery, B, passes through the galvanometer, G, and a conducting wire to h , where the two experimental wires, x_1, x_2 , are joined; the other ends of them being brought into contact with a current reverser, C, by means of the brushes, b and c . From C the current is

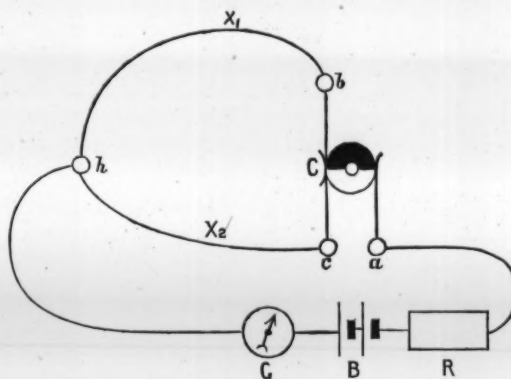


FIG. 3.

conducted by a third brush, a , through a wire to the rheostat, R, and thence back to the battery, B. The current reverser is constructed as shown in fig. 4, from which it is evident that with each revolution, through one half of it the spring, b , and through the other half the spring, c , is brought in circuit with the spring, a ; and that whilst c is in circuit, b , by means of insulating material, is cut out and *vice versa*. By the revolution of this reverser we send the current alternately through x_1 and x_2 always in the same direction, whilst

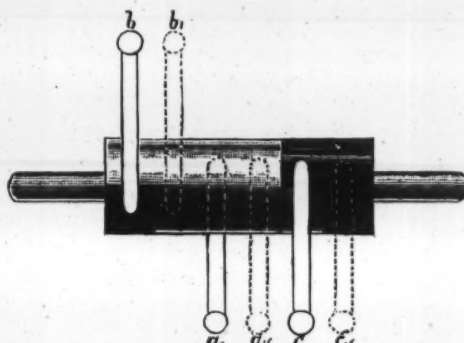


FIG. 4.

keeping up a continuous current in the rest of the circuit. The effect of sending a current in the same direction alternately through the two wires will be equivalent to interrupting a continuous current in one and the same wire.

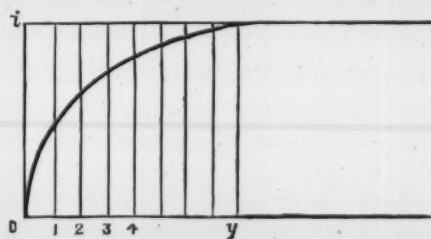


FIG. 5.

To measure the stable current in either one of the two wires the reverser or interruptor, as shown in fig. 4, is shifted along its axis, whereby the springs, a, b and c , come into a position in relation to the reverser as indicated by the dotted outlines, a_1, b_1, c_1 , in

which position, c_1 , is cut out of circuit, whereas a_1 and b_1 remain in contact, at whatever speed the reverser or interruptor may revolve. The measurements here also are made by adjusting R to get constant indications in G ; and the potentials between a and b can be ascertained.

This latter arrangement admits of being used in the Wheatstone bridge by making the two wires, x_1 and x_2 , and the reverser C , that is, the part, a, b , to form the unknown arm in the bridge. So used, the resistance of x with a variable current could be balanced against a stable current in the remaining arms of the bridge.

I can but regret that multifarious harrassing engagements have prevented me from giving the subject the time and attention it deserves; and I must beg your readers to bear with me for the many shortcomings and imperfections, which are only too conspicuous in both communications.

C. GODFREY GÜMPEL.

Carlton, Burstow, Surrey.

tric spark, and the difficulties which have previously been experienced in electric ignition have been successfully overcome by the inventors, Messrs. Delaware and Malandin.

There are several advantages claimed for this electric ignition; poorer gases and mixtures can be fired, a greater number of ignitions in a given time can be assured and so a quicker running engine employed; the slide valve is comparatively cool, and the constant cleaning in the gas flame ignition from deposited carbon due to the heat of the slide valve is unnecessary.

The governor we show on an enlarged scale in fig. 2. It is simple and ingenious, and not only controls perfectly the speed of the engine, but permits the number of revolutions per minute up to the maximum of the engine to be varied by opening or closing the cone, R , by the screw, S .

The slide valve, A , is shown at its extreme outward position, and the spark, b , is shown in communication

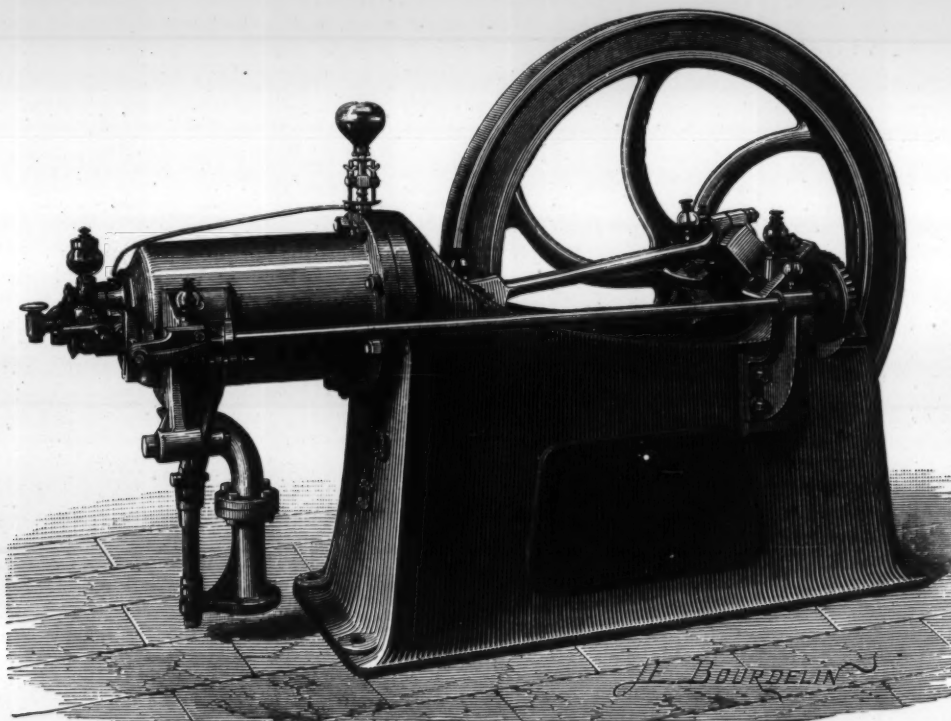


FIG. 1.

"LE SIMPLEX" GAS ENGINE.

A GAS engine, constructed by M. Thomas Powell, of Rouen, France, and which has been named "Le Simplex," has lately been prominently brought before the French public by a very satisfactory test made on it by Dr. Witz, of Lille, a professor well known by his several original experiments and publications on the behaviour of gas explosions in cylinders, &c.

The results of this trial are given in the table we publish, taken from the official report, and it will be seen that the engine is not only an exceedingly economical one in its consumption of gas per horse-power, but very regular in its speed. These, and the details of the engine, we think of sufficient interest to bring before the notice of our readers.

The engine is single acting, of the compression type, with an explosion at every second revolution, a type invented, we understand, by a French engineer, Beau de Rochas, but known in England in connection with the Otto engine.

From the illustrations the engine appears to bear out its right to its name.

The mode of ignition and the air pump governor are its two chief peculiarities. The ignition is by an elec-

with the cylinder port, H . The passage, B , in the slide valve, comes opposite G and H to admit gas and air; but just before this takes place the gas valve is opened by the knife edge, Q , coming into contact with the gas valve spindle, U . The governor, T , being connected to the slide valve, moves with it, and as T moves forward, the plunger M , attached to the slide valve cover, being stationary, compresses the air in T . The amount of opening given by the cone, R , regulates the speed at which this air escapes; should the engine increase its speed in the slightest, this air, unable to escape at an increased rate, presses outwards the side piston, O , and the knife edge, Q , misses the gas valve spindle and no gas is admitted.

The engine was tried by Dr. Witz with ordinary lighting gas and Dowson's gas, with both of which it worked equally well; with the poorer gas the compression chamber was reduced by adding a packing piece to the piston, the compression chamber for the ordinary lighting gas being 32.4 per cent., and for Dowson's gas 25.6 per cent. of the cylinder volume.

The report, which we have not the space to publish in full, gives all the details of the trial.

Dr. Witz states that the indicated horse-power is too low, the difficulty in obtaining the true indicated

power being due to the inertia of the spring and moving parts, &c., at such speeds and pressures. We expect to hear more of this engine, which appears very suitable for dynamo driving.

Dowson's gas, as most of our readers are aware, is a cheap gas made direct from anthracite coal, its power being about one-quarter that of ordinary coal gas.

The heating power of the ordinary gas used was 5,400 calories per cubic metre. Diameter of cylinder $7\frac{1}{2}$ inches, and $15\frac{1}{2}$ inches stroke.

of half an hour each, were made to prove the efficiency of the governor. The power varied from 5.66 brake horse-power to 3.33 B.H.P., and the following is the average speeds taken from the counter every five minutes:—

Trial No. 6 ... 159.8, 159.6, 158.4, 159.8, 156.0, 158.6.

„ No. 7 ... 160.6, 159.2, 159.4, 159.4, 159.8, 156.2.

COMPRESSED AIR MOTORS FOR ELECTRIC LIGHTING.

THE working of the pneumatic clocks established in Paris demands a certain quantity of compressed air, the production of which, in the centre of the town, at the very point where the distribution took place, entailed several inconveniences.

M. Popp, the director of the Pneumatic Clock Company, was therefore compelled to establish works, for the production of compressed air, in the Rue Saint Fargeau, and to transport it to the Rue Sainte-Anne by means of a wrought iron conduit, 8 centimètres in diameter inside, laid down in the sewers, extending as far as the Place du Château d'Eau, through the streets Saint Fargeau, Ménilmontant, Oberkampf, the Boulevard Richard-Lenoir, and the Rue de la Douane. From the Place du Château d'Eau the canalisation follows the large boulevards as far as the Place de l'Opéra, the Avenue de l'Opéra, ending at No. 7, Rue Sainte-Anne. It is thus possible to establish along the course of this canalisation branch tubes of compressed air directly available for starting motors working dynamo-electric machines.

The work per revolution and the expenditure of compressed air being practically constant for a given type, it is sufficient to adapt a register of revolutions to the axle of each motor, in order to ascertain the mechanical energy supplied to the consumer in a given time, and estimate his consumption of motive power. The actual average price is we believe, 70 centimes per H.P. hour, or about 1 centime per kilogramme-hour.

The accompanying figure, from *La Nature*, shows one of the installations of electric lighting made according to this system. The compressed air motor, the normal speed of which is 160 revolutions per minute, works a Gramme machine excited in derivation, turning at 1,400 revolutions per minute, and able to give 40 ampères and 100 volts at the terminals, representing 4,000 watts or 5.5 available electrical horse-power.

Incandescence lamps of Messrs. Woodhouse and Rawson are arranged two in series, and each take 48 volts and 0.9 ampères, with a luminous power of about 15 candles. The lamps are lighted in independent groups, by a commutator established on the ground floor, within reach of one of the cashiers of the café, to whom the working is entrusted. The slight variations of luminous intensity that might result are greatly lessened by a series of 48 accumulators mounted in derivation on the terminals of the machine.

The system of regulation adopted in this installation and other similar ones, does not, writes M. Hospitalier, seem to meet the special requirements of the installation. The regulator employed regulates the variations in speed of the machine, but from the principle of the system itself, it is when the machine is producing the least work that it allows of the greatest speed, whereas the contrary ought to be the case, the machine requiring to turn somewhat faster when all the lamps are lit than when only a few are in use.

The regulator should therefore act in this particular case, not only on the speed of the machine, in order to limit the variations, but also on the circuit of excitation, so as to increase the resistance of this circuit when the machine is going rather too fast, which means that it is only feeding a few lamps, and

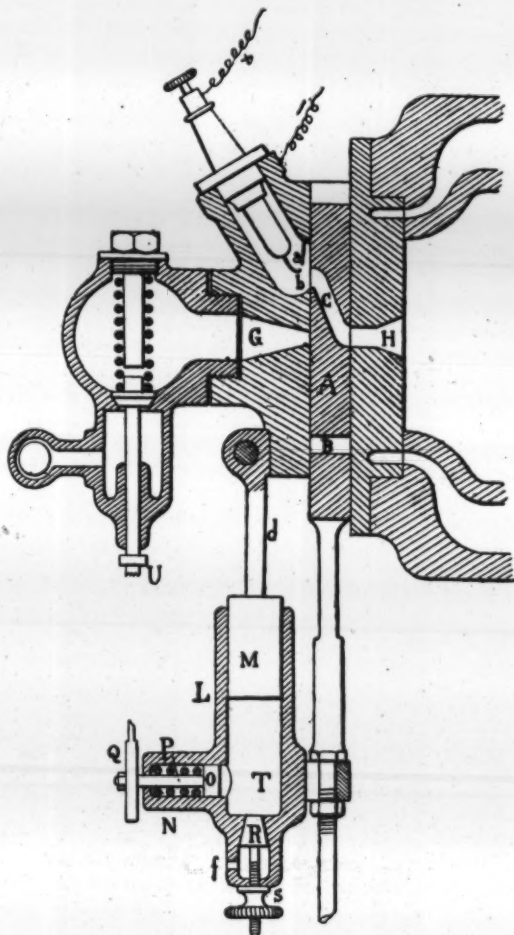


FIG. 2.

EXTRACT FROM THE REPORT OF M. A. WITZ ON THE CONSUMPTION IN THE ENGINE.

Duration of the experiment.	Revolutions per minute.	Effective work.	Water per effective H.P.	Gas per effective H.P.
EXPERIMENT ON NOVEMBER 7TH WITH TOWN GAS (Engine 8 H.P. nominal).				
2 hours	161.2	8.79 H.P.	19.9 litres	577 litres
1 hour.....	157.4	9.41 „	19.6 „	593 „
EXPERIMENT ON NOVEMBER 8TH WITH DOWSON GAS (Engine 6 H.P. nominal).				
2 hours	163.9	7.22 H.P.	26.1 litres	2,518 litres
1 hour.....	159.1	5.33 „	...	2,813 „

Compression for ordinary gas, previous to explosion, 65 lbs. per square inch; maximum pressure after explosion, 312 lbs. per square inch; and with Dowson's gas 96 lbs. and 312 lbs. per square inch.

Piston speed 425 feet per minute. Two experiments,

to diminish the resistance when it is turning more slowly. Or, we might employ an electrical governor maintaining constant, not the speed, but the difference of the potentials at the terminals of the machine. It is under these conditions that we shall arrive at a veritable distribution, and that the absolute independence of the lamps will be ensured.

Similar installations, both of arc and incandescent lamps, are established along the course of the canalisation, and others are in course of preparation; the demands exceed the total capabilities of the canalisation, and M. Popp is endeavouring to meet them by increasing the diameter of the pipes, and by effecting indirect lightings by means of accumulators charged during the day, when the direct lightings cease. This is the best proof of the success of this distribution of motive power but that should not lead us to believe that the distribution of motive force by compressed air is an advantageous method or one superior to other known systems. We must not, in fact, forget that the rendering of a distribution of compressed air is very low, less than 40 per cent., that it

THE STRANGE HISTORY OF A DYNAMO

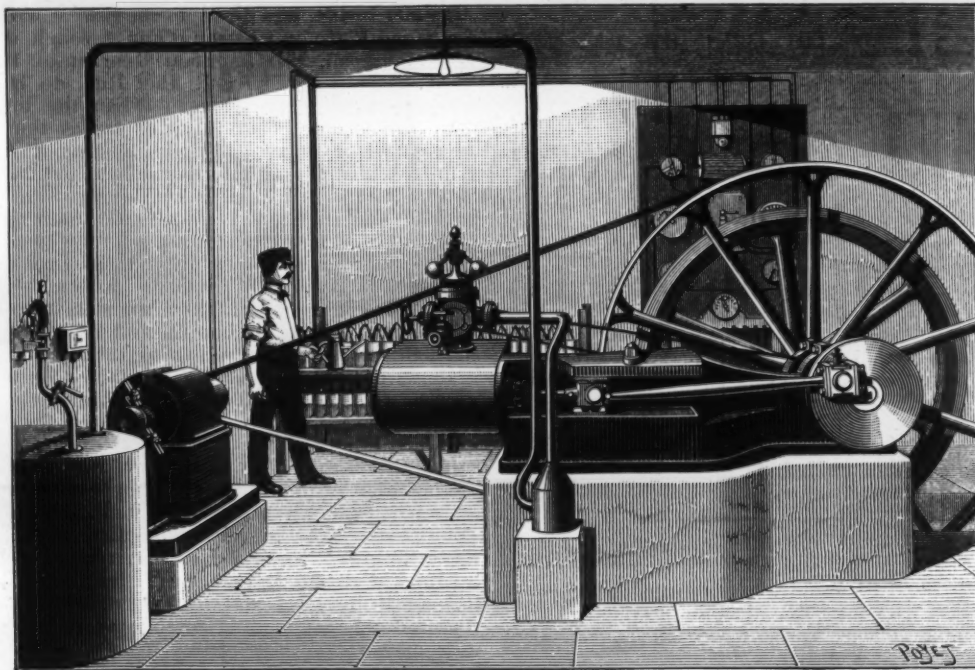
As told by itself to

A. DYNAMICABLE.

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(Continued from page 423.)

I HAVE already explained the manner in which electric currents are produced in a coil of wire by the rapid insertion and withdrawal of a magnet; I need scarcely remind you that precisely similar effects would be produced if the magnet were made stationary and the coil left free to slide backwards and forwards upon it. The improvement introduced in the means of producing currents by Dr. Werner Siemens, whose armature was made to revolve in an intense magnetic field, with the effect of obtaining increased results and greater economy in construction, is also familiar to you, therefore no surprise need be manifested at what I shall now show you with my ring form of armature, as devised by Pacinotti.



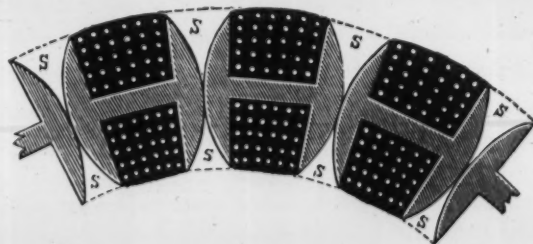
Installation in the Basement of the Café de Paris.

diminishes very rapidly in proportion as the initial pressure is increased, that it only supplies motive power, and indirectly electrical energy after a second transformation, and a second installation, whereas a distribution of electrical energy would supply, directly, with a higher rendering and greater conveniences, either the necessary electrical energy for incandescence lamps, or the motive power required for other industries.

While acknowledging the advantages of the system, and admitting that we should certainly avail ourselves of it for the purposes of canalisation, we must still assert, that, in our opinion, the distribution of compressed air is simply a provisional solution, experimental and temporary only, and that in the future a distribution of electrical energy awaits us that will supply us directly and at will with light and motive power, from the central works, without our having to trouble ourselves in the matter.

On the Thames in an Electric Launch.—The turbaned Hindoo to whom we referred in our last week's article, turns out to have been no other than His Highness the Thakore of Gondal, Katyawar, India.

Some persons of a hypercritical turn of mind might go so far as to say that a Pacinotti ring looks suspiciously as if made up of a number of Siemens armatures, placed round in a circle and end on, as partly

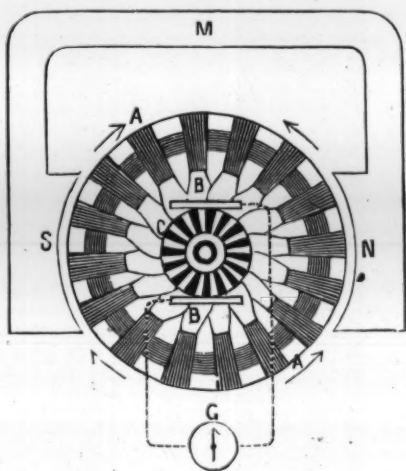


PORTION OF RING FORMED OF SIEMENS ARMATURES.

shown in this sketch. So it does; and, indeed, a ring formed in such a manner would act as a capital substitute for that of Pacinotti, the only difference being that in the former the projections or teeth have a space, *s*,

whilst in the latter the teeth are solid. Nevertheless, it must not be supposed that Pacinotti ever had the faintest notion of this; I make the suggestion in the light of a knowledge with which I was not endowed at that time.

Now, by the aid of another sketch, I will ask you to imagine a Pacinotti ring attached to an axle upon which it can rapidly rotate, and placed between the poles, N and S, of the magnet, M. I have before, by means of a previous diagram, shown the manner in which the coils of copper wire wound in the grooves



DIAGRAMMATIC REPRESENTATION OF PACINOTTI MACHINE, WITH PERMANENT MAGNET FIELD.

around the ring were connected together, so I need only mention here that C is the current collector, formed as previously explained; A, A, are the coils of wire, and B, B, are two collecting brushes or rubbers, from which the current produced may be taken. Now to speak of the action which ensues when the ring is set in rapid rotation.

From the remarks I have let fall concerning the Siemens armature, you can see that the magnetic effect which is set up between the N and S poles of the magnet, M, and the iron ring is very powerful, owing to the proximity of the teeth to these poles. We may say, then, that an intense magnetic field is thereby produced.

You think the meaning of "magnetic field" would be made more clear by further reference thereto? Very good; here is a simple example! If we bring a piece of iron near to the end of a magnet, it is assumed that invisible lines—"lines of force" as they are technically called—are set up, or pass, between the magnet and the iron. This assumption has been deduced from a simple experiment. If we place over our magnet, M, and its attendant piece of iron, I, a pane of glass, G, and sprinkle thereupon some fine iron filings, these latter distribute themselves in lines, somewhat in the following manner:—

Similar, but invisible lines are supposed to exist pervading the space between the magnet and the iron; these are the "lines of force," and when a wire is made to pass through these lines in a direction at right angles to them, it is said to pass through the magnetic field and cut the lines of force; the consequence of this is that a current is induced in the wires, or coils of wire, which come within the influence of the magnetic field.

A Pacinotti ring, therefore, revolving rapidly in the magnetic field produced between itself and the end of the magnet, M, must necessarily cause electric currents to circulate in all the coils surrounding it. These currents flow in the direction of the arrows, + or positive in one half of the ring, and — or negative in the other half. The brushes, B, B, rubbing on the collector enable us to take off continuously the currents produced, which are always in the same direction, as could

be seen by the deflection of the galvanometer, G, so that at last we had here a source of electrical energy precisely similar in effect to that of a galvanic battery, only many times more powerful than the ordinary sized galvanic cells.

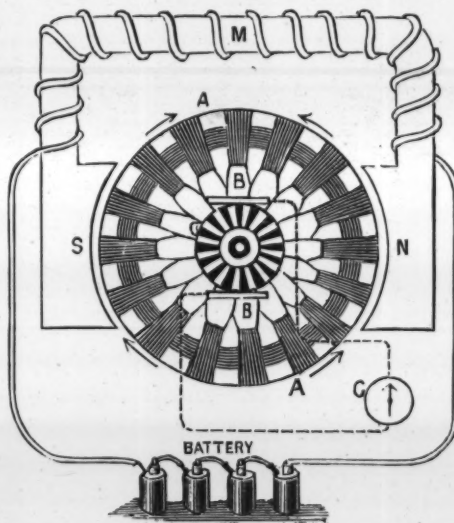
In referring some time since to the English electrician, Sturgeon, I spoke of the vastly greater power which an electro-magnet possesses over the permanent form. If, then, we substitute the one for the other, exciting the electro-magnet by a galvanic battery, we get a much more intense magnetic effect, and consequently more powerful currents from the ring, at the expense, of course, of extra labour in revolving it.

Pacinotti, indeed, employed the electro-magnet to produce the magnetic field, but I preferred to give you as a typical example of his invention the permanent magnet, as being more simple.

Yes; the diagrams, as you assume, are not quite in accordance with the original construction of the Pacinotti apparatus, but they explain precisely the principle upon which it was based.

You have a dim recollection of seeing something answering to my description in the Paris Exhibition of 1881? You are correct; I was there, and in the guise depicted in this illustration, having thus existed since the year 1860. Whether it was that Pacinotti failed to see the great future before me, or whether the time of day was not then sufficiently ripe to turn me to a satisfactory account, is a matter upon which I will leave you to ponder.

As you will notice, there are points in construction to which I have not alluded in explaining the principle; these, however, are details which do not form a theme of interest to the general reader, and as for yourself, well! with these you are familiar. Some time previous to 1860 a Dane, Soren Hjorth, patented an invention in which the principles I have just enumerated were fully explained. I have never been able to satisfy myself that he ever constructed his proposed apparatus, which would, however, have been of essentially different construction to that of Pacinotti. Indeed, at this time, so little public interest



DIAGRAMMATIC REPRESENTATION OF PACINOTTI MACHINE, WITH ELECTRO-MAGNETIC FIELD.

was manifested in inventions of the kind that I doubt whether Pacinotti's apparatus was known in this country 10 years ago, or if ever made public it had been forgotten. It is not a little interesting to know that the apparatus of the clever Italian was constructed by him to act not only as a generator of electrical energy but also as an electro-motor, the respective properties or duties of which I have mentioned. The reversibility of the Pacinotti machine affords a means of electric, or rather of electro-mechanical storage. Suppose we want to store electric currents. Set them to drive a Pacinotti machine as an electro-motor, and let it, by

means of a pulley, gradually wind up a very heavy weight. If, subsequently, we let the weight descend, it will drive the machine, which in its turn will generate currents as it runs down.

Pacinotti one day, when describing me, said: "It seems to me that that which augments the value of this model is the facility which it offers of being able to transform an electro-magnetic machine into a *magneto-electric machine with continuous currents*. If, instead of the electro-magnet there were a permanent magnet, and if the ring were set turning, one would have made it into a magneto-electric machine, which would give a continuous induced current, directed always in the same sense."

There was one drawback, however, attached to me in those days; to render me capable of generating electric currents, it was necessary to employ either a permanent magnet which produced a somewhat weak magnetic field, or an electro-magnet whose more intense magnetism was effected at the expense of a galvanic battery.

It was reserved for another of your countrymen, Mr. S. A. Varley, to whom I casually referred when speaking of Faraday's labours, to discover the self-exciting or mutual accumulation principle upon which *all* the dynamos by which you are surrounded act.

It is known that iron, which I have previously said does not retain magnetism in the manner of steel, still

ELECTRICITY ON BOARD THE "TAKACHIHO KAN."

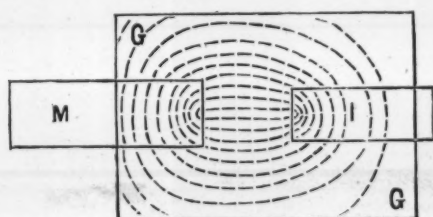
THE magnificent cruiser, *Takachiho Kan*, built for the Imperial Japanese Navy by Messrs. Sir W. G. Armstrong, Mitchell & Co., left the Tyne on her voyage to Japan on the morning of the 6th inst.

This vessel, which is of 3,600 tons displacement and over 7,500 H.P. is, excepting only her sister ship the *Naniwa Kan*, now well on her homeward voyage, the fastest and most redoubtable cruiser at present afloat, her mean speed of 18.8 knots being second to none.

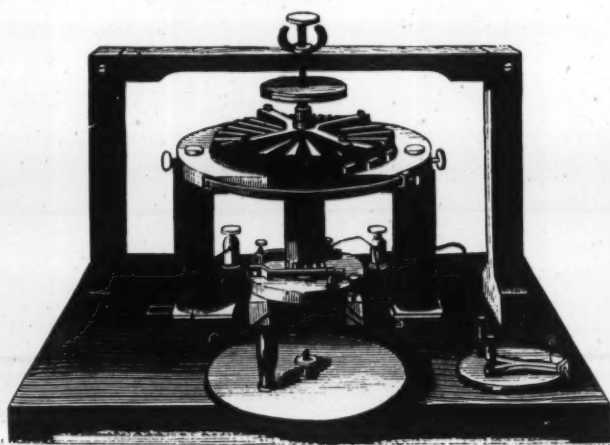
On each of these ships (the two are precisely similar in every detail), electricity is well to the fore.

The two 25 ton 10 inch and six 6 inch guns, are all fitted with electric firing gear, so that by pressing a key in the armoured conning tower on the forward bridge, a broadside of five guns can be simultaneously discharged. The correct aim is obtained by means of an instrument called a *director*, which is a species of fixed adjustable telescope, ten guns being so laid that if fired when a definite part of the target is visible through the director, the several shots will all strike the target at identically the same place, this being of great importance where armour is being dealt with.

The ship is also fitted with four tubes for discharging locomotive torpedoes, which are fired electrically from stations on the upper deck in a similar manner to the



A MAGNETIC FIELD.



THE ORIGINAL PACINOTTI ELECTRO-MAGNETIC OR MAGNETO-ELECTRIC MACHINE.

shows traces in a very slight degree after magnetisation, and to the uses to which the *residual* magnetism which exists in even soft iron was directed, we owe the rapid progress which has since been made in dynamo construction. In fact, here was the true dynamo-electric principle which enables a machine in itself to develop the greatest magnetism in its electro-magnets from the very feeble residual magnetism or initial energy residing in its iron cores, and which gave for the first time full importance to Pacinotti's invention. As both the late scientists, Sir Charles Wheatstone and Sir William Siemens, have hitherto received the credit of this most important discovery, it is naturally very important that I should show you conclusive proofs of the priority of Mr. Varley's claims, and to this task I cheerfully devote myself.

(To be continued.)

Nothing like Leather.—It is unofficially stated that since the removal of telephones in the city of Indianapolis the streets have taken on a much more business-like appearance. This is due to the fact that business men are compelled to run all over the city, spending half a day attending to business that was formerly completed in five minutes in their office, by use of the telephone. The shoe trade is looking up in Indiana.

guns. Each tube has, however, its own director and firing key, and is independent of its neighbours.

As regards electric lighting, the two engine-rooms, the stokeholes, coal bunkers, magazines, captains' cabins and chart-house, are fitted throughout with 16 C.P. Swan incandescent lamps, 108 being the total number employed.

There are also four search lights, each of 25,000 C.P., two on each bridge.

The generating plant consists of four dynamos driven by two of Messrs. Goodfellow and Matthews's compound "triplex" engines. Two of the dynamos with their engine are in the forward part of the vessel, while the others are in the forward engine-room, all being below the water line, and under the 3 inch protective steel deck which covers all the vitals of the ship. A system of trunk wires between the switchboards at the two dynamo stations permits of any dynamo being connected to any of the four search lights or eight incandescent lamp circuits.

The whole of the electric light installation, including search and incandescent light circuits and trunk connections is wired on the double wire system according to a new and original plan worked out by Mr. A. A. Campbell-Swinton, electrician to Messrs. Sir W. G. Armstrong, Mitchell & Co., by means of which the customary unsightly and costly wood casing is entirely done away with, the wires, great and small,

having a watertight lead skin which sufficiently protects the insulation without any further covering.

This arrangement, while presenting a particularly neat appearance, has proved very efficient and satisfactory in practice.

The entire lighting and other electrical installations have been carried out by the electrical department of Messrs. Sir W. G. Armstrong, Mitchell & Co., the builders of both vessels.

THE EDINBURGH EXHIBITION.

THIS Exhibition was opened on the 6th inst. by Prince Albert Victor with the usual pageantry and loyal demonstrations in the way of presentations and addresses.

Throughout the day direct telephonic communication with Glasgow was maintained from the National Telephone Company's stand in No. 19 Court. The arrival of the Prince in the Exhibition was immediately telephoned to Glasgow, as were also his subsequent movements till the close of the ceremony.

All the evening the building and grounds were crowded almost to inconvenience. Between seven and eight the waning daylight caused the electric light to be brought into requisition in the Exhibition. The central corridor was instantaneously lighted up with the incandescent lamps provided by Messrs. King, Brown & Co. The great hall and the side courts were also lighted up with the arc lights of the Brush Company, Gülcher & Co., Andrews & Co., and Mr. Miller, who provides the Thomson-Houston lamps. The lighting was entirely satisfactory both to the electricians and the public, the arc lamps burning with a perfectly pure and steady light.

The total number of visitors for the day, including season ticket holders, is estimated at upwards of 40,000.

The Gülcher Electric Light and Power Company, Limited, has favoured us with the following official account of its installation:—

Lighting of Section C.

This section is lighted by 32 3,000-candle-power Gülcher arc lamps, placed four in each court, and suspended by the company's improved raising and lowering counterbalance arrangement, the method of suspension dispensing with all slack unsightly cable, as the current for working the lamp is carried by the suspending cord, avoiding the inconvenience of pulleys and ropes. Each arc lamp is worked by an independent switch, so that any number of lamps may be used as desired.

Reception Rooms and Stalls.

The two reception rooms and many of the exhibitors' stalls are lighted by incandescent lamps suspended either by pendants or fittings as found most suitable, the current being taken from the dynamo as for the arc lamps, which clearly demonstrates the advantages of the Gülcher system for indoor illumination of public buildings or factories, as it enables a combination of arc and incandescent lamps to be driven from one dynamo.

Ground Illumination.

The grounds are lighted by 32 2,000-candle-power Gülcher arc lamps, constructed for outdoor work, fitted with clear glass globes and white reflectors, the lamps are suspended in groups of four arranged on high poles, each of which is fitted with a special head gear for carrying the lamps and to enable them to be raised and lowered as required, and each arc lamp (as at section C) is fitted with a switch.

Engines, Dynamos, &c.

Engines.—The installation is driven by a pair of 50 H.P. nominal horizontal high pressure engines by Messrs. Robey & Co., of Lincoln, specially constructed for driving electric light machinery, and fitted with special automatic cut off gear, which effectually regulates the speed of the engines.

Dynamos.—The current for working the 64 arc lamps and incandescent lamps is generated by four No. 5 compound wound Gülcher dynamo machines of the company's most improved type. Each dynamo is capable of giving a current of 300 amperes at an estimated total of 65 to 70 volts at the terminals with a speed of 500 revolutions per minute, and will drive either 20 3,000-candle-power arc lamps, 37 2,000-candle-power arc lamps, or 300 to 350 20-candle-power incandescent lamps.

If desired, a combination of arc and incandescent lamps may be run from the same machine.

The dynamo is very substantially constructed; the bearings are very long, and fitted with special oiling arrangements and oil catches. The armature is balanced, and in case of an accidental breaking off, any of its sections can be very easily repaired, and all parts are readily accessible.

The foreman electrician to Messrs. King, Brown and Co. writes to us on the subject of lighting the Exhibition to the following effect:—

"Allow me to correct your account of the 7th inst., regarding the lighting of the central corridor at the Edinburgh International Exhibition, which has a total of 75 girders, each one having 19 lamps, making a total of 1,425; there are two lavatories, each with 10 lamps, and a great many exhibits which are fed from the same circuits, which number over all 1,460.

"These circuits are so arranged that half may be turned out, still leaving every other girder alight; there are six sections, and six dynamos produce the current for the whole corridor; these are supplied by power from three vertical Marshall engines of 14 H.P. each, and there are also one vertical engine and two dynamos which are kept in reserve.

"The outside lighting is effected by 1,200 lamps of 10 C.P. each of 96 volts; these are a speciality in a 10 C.P. lamp, and are supplied by the Edison-Swan Company. For these are used, two horizontal Marshall 10 H.P. engines, driving two dynamos.

"You will see from this that there are only eight dynamos in actual work and five engines."

THE NEW ELECTRIC LIGHTING BILLS.

THE bills introduced by Lord Rayleigh, Viscount Bury, and Lord Houghton, with the object of amending the Electric Lighting Act passed by Mr. Chamberlain in 1882, have this week been under the consideration of a Select Committee of the House of Lords, consisting of Lord Camperdown (Chairman), and Lords Cowper, Balfour, Bury, Rayleigh, Houghton, Bramwell, Crawford, and Wolverton. We have, in these columns, explained at some length the provisions of these bills; and accordingly it is now necessary only briefly to recapitulate their leading features. Those interested in the progress of electric lighting are aware of the complaints as to the stringency of the provisions of the Act of 1882. The loudest outcry was against clause 27, which lays down the conditions under which the undertaking of a private company may be acquired, compulsorily, by the local authority. This provision authorises the compulsory purchase, by any local authority desiring to do so, of the undertaking of any electric lighting company supplying any part of the area within the jurisdiction of such local authority, at the termination of a period of 21 years. Not only does it thus render a company liable to have its business taken over at a time when it may only have begun to be profitable, but the clause goes on to enact that no allowance is to be made for the goodwill of the business thus taken over, or compensation for disturbance or loss of profits; but that the sole price to be paid shall be the then value of "all lands buildings, works, materials, and plant," suitable to the company's operations. Such an enactment is regarded as unjust to the Electric Lighting Companies, who may be only beginning to reap a return for the use of their capital when the enterprise in which it is invested may be taken from them by the local authority under this one-sided "power of purchase" clause. There are other features in the Act of 1882 to which the Companies take exception; but this clause is their peculiar *bête noire*; and the main object of all the three bills now before their Lordships' Committee is to amend this objectionable provision. Lord Rayleigh's bill, which was the first introduced, is a measure the clauses of which seek to give legislative effect to the views of the Electric Lighting Committee. It proposes to purge the Act of 1882 by the effectual method of the entire repeal of clause 27, and the substitution therefor of a provision similar to that in the Public Health Act of 1875, sanctioning the acquisition of gas undertakings by "agreement," upon "any terms" that may be

arranged between the Local Authorities and the Gas Companies. Other clauses of the sixteen of which this bill is composed seek further to assimilate the legislative conditions under which the business of supplying the electric light may be carried on to those which prevail in regard to gas companies. Section 4, 5, and 6 enact penalties for the fraudulent use of electricity, or wilful damage to works, lamps, &c. Section 7 proposes the repeal of so much of section 18 of the Act of 1882 as prohibits the Electric Lighting Companies from prescribing any special form of lamp or burner, or otherwise controlling or interfering with the manner in which electricity supplied by them under their Act is used. Sections 9 and 10 apply to capital and dividends, and in these respects proposes, as in the case of gas companies, that each Provisional Order, or Special Act, shall fix a standard dividend and a standard price for electricity. Then the gas sliding scale is brought into operation, and the dividend may be increased by a quarter per cent. for every reduction of a farthing in the price of the electrical unit; while any excess of profit over the amount necessary to pay the dividend is to go to form a reserve fund. When the creation of new capital is sanctioned, this bill provides that it shall be sold by public auction, or tender, at a reserve price not lower than its nominal value. Viscount Bury is responsible for the introduction of the second amending bill. It also proposes the repeal of the 27th clause of Mr. Chamberlain's Act, and the substitution therefor of provisions to the effect that where undertakers are authorised to supply electricity within any area, the local authority of that area may, after the termination of 41 years, and within six months after the expiration of every subsequent period of seven years, require the undertakers to sell to them their undertaking, "upon terms of paying the then value thereof as a going concern." Lord Bury's bill, moreover, would remove the prohibition resting upon the companies of prescribing any special form of lamp or burner for use by their customers; and it would also authorise the Board of Trade to grant licences to companies seeking to supply areas whose local authorities already hold a licence or provisional order for the supply of electricity, without the consent of those local authorities. Lord Houghton is in charge of the third bill which the Board of Trade, on behalf of the Government, has drafted. It proposes that the period within which compulsory acquisition by the local authority shall not be possible shall be specified in the Provisional Order or Special Act under which the Electric Lighting Company is carrying on its operations; that such period shall not exceed 42 years; that where no period is specified in the Order or Act, the period shall be deemed as one of 30 years; and that no period exceeding 30 years shall be specified, except with the consent of the local authority of the area within which the Order or Act would apply. As will be understood, the Gas Corporations and Companies view with little favour the proposed alterations, and they, as well as the friends of electricity, were well represented at the Committee on Monday. Many corporations have petitioned against the bills, including those of such important municipalities as Birmingham, Blackburn, Bolton, Burnley, Dundee, Edinburgh, Glasgow, Leeds, Liverpool, London, Manchester, Newcastle, Nottingham, and Paisley. The Committee conducted its deliberations and heard evidence in private, and we understand that on all who were admitted within the room the seal of secrecy as to what was said and done was imposed.

The witnesses examined included Mr. L. L. Cohen, M.P., Mr. Hucks Gibbs, Prof. George Forbes and Mr. Crompton. The committee adjourned at four o'clock, and resumed hearing evidence on Wednesday, when the proceedings were conducted with the same privacy as on the previous day.

INCANDESCENT LAMP PATENTS.

EDISON v. WOODHOUSE AND RAWSON

AND

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY v.
WOODHOUSE AND RAWSON.

(Before Mr. JUSTICE BUTT, sitting for Mr. JUSTICE NORTH.)

Monday, May 10th, 1886.

In this action for infringement of incandescent lamp patents Sir Richard Webster, Q.C., Mr. Aston, Q.C., and Mr. Fletcher Moulton, Q.C., instructed by Messrs. Ashurst, Morris, Crisp and Co., were the counsel for the plaintiffs, and the Solicitor-General Sir Horace Davey, Q.C., Mr. Charles, Q.C., and Mr. Macrory instructed by Mr. Sidney Morse, were counsel for the defendants.

Sir RICHARD WEBSTER, in opening the case, stated that the first action was upon three patents, and in the course of his opening in the first action he would have to state the course of knowledge which involved the patent in issue in the second action. The first action was brought in respect of the infringement of three letters patent belonging, the first to Mr. Edison, the second to Mr. Swan, and the third to a Mr. Gimson. The date of the first is November 10th, 1879, No. 4,576; the second, January 2nd, 1880, No. 18; and the third, September 29th, 1881, No. 4,193. All three relate to the construction of an incandescent electric lamp, consisting of a glass receiver, or bulb, hermetically sealed, also by glass, containing a filament of carbon, exhausted of air and

attached to platinum wire, which lead through the bottom of the glass for the purpose of conveying the current. The Edison patent, speaking generally, relates to the combination of filament and glass receiver or platinum wires, leading to the carbon filament inside. The Swan patent relates to the way in which the vacuum is obtained after the lamp has been put together. The Gimson patent relates to the mode of attachment, or of making contact, between the platinum wire and the carbon. It is a special manufacture where the platinum ends and the carbon begins. Whatever the merits of Mr. Edison, in this case it could not be seriously contested but that the combination before them, the result of Mr. Edison's invention and description, solved the problem of electric lighting. For 35 years inventors, in America, on the Continent and in England, had been endeavouring to solve the question; they had arrived at certain points, and apparently the road was barred for further investigation beyond the points to which they had reached. He had not the smallest wish of underrating the very great part played by other men in this discovery, but his case was that that combination of Edison's solved for the first time the question of practical electric lighting by incandescent lamps. For the purposes of the case they had only to consider the question of the branch of lamps of the incandescent character. There are, in between the arc and the incandescent, some which have been called semi-incandescent; but these would be disregarded. Mr. Edison's specification was taken out on November 10th, 1879, and his final specification was filed on April 20th, 1880. He describes the invention in this way: "It is necessary to practically sub-divide the electric light into a great number of luminous points, so that lamps connected in multiple may be employed without the necessity of using conductors of great size for the current to the lamps. It is essential that the lamps should be of great resistance. In the Provisional Specification of Patent dated June 17th, 1879, No. 2402, I have set this forth and obtained lamps of great resistance by employing long lengths of platinum or metallic wires pyro-insulated and wound in such a manner that but small radiating surface is exposed to the air, although a great length of wire is used. My present invention relates to lamps of a similar character, except that carbon threads or strips are used in place of metallic wires. I use a block of glass into which are sealed two platinum wires. These wires serve to convey the current to the electric lamp within a bulb which is blown over the lamp and united to the glass block. The bulb is exhausted of air to about one millionth of an atmosphere. Upon the ends of these wires are two clamps that secure two other platinum wires. The burner consists of a filament or thread of carbon preferably coiled with the ends secured to the platinum wires. The main discovery, the discovery of Mr. Edison, in this connection was the utilisation of a filament or thread of carbon, meaning thereby a substance which is made into a filament or thread, or may be so made, before it is carbonised. Attempts to light by cutting down blocks of carbon from a thick piece to a thin piece, had been made and had failed, and even now fail, with all the knowledge we have at the present time. The point, the touch-stone, of the invention, and which has made the lamp from being a laboratory experiment into a practical, useful article, was the use of a filament or thread, that is to say, something made a filament before it was carbonised. "Fibrous material such as paper, thread, wood, or any vegetable or animal matter which can be carbonised has the end secured to platinum wires, the fibre is wound in such a shape as to expose the least amount of surface to radiation, such as in a helix or spiral. The helix is secured to the platinum wires by plastic carbon, and the whole is placed in a closed vessel free from air and subjected to a heat sufficient to fully carbonise the fibre and leave nothing but carbon. At the same time the effect of the carbonisation is to lock the carbon to the platinum wire and make good connection." That meant making carbon and platinum unite closely at the point of contact; otherwise, when the current went through there must be local action set up, which might tend to injure the connection between the two. "These wires are secured by the clamps to the two platinum wires in the bulb, and the bulb is exhausted of air and sealed; lamps of 100 ohms resistance may be made in this manner from which light from the incandescent carbon is obtained. The destruction of the fragile carbon by oxidation is prevented by the high vacuum which is obtained before sealing the glass bulb. Previously to my invention carbon sticks have been used, but they have only had a resistance of three or four ohms, and none have been used in vacuum bulbs composed entirely of glass except the leading wires, hence the difficulties of sealing leading wires into glass which would convey a current of sufficient strength to a lamp of but three or four ohms resistance, are too great to make such a lamp successful." This statement of the previous knowledge was practically accurate, but was not absolutely so, because undoubtedly Mr. Swan, whose merit in the invention was not one whit less than Mr. Edison's, had about this time conceived the idea of putting carbon sticks into a vacuum bulb composed entirely of glass. He had never thought of, or brought out the filament or thread part of it, but he had thought of, and had actually made a lamp in which the stick of carbon had been put in a receiver entirely of glass. Therefore, so far Mr. Edison was not quite right in saying that none had been used in vacuum bulbs composed entirely of glass except the leading wires; but as a practical question of what was generally known he was perfectly correct. "Hence the difficulties of sealing leading wires into glass which would convey a current of sufficient strength to a lamp of but three or four ohms resistance, are too great to make such a lamp successful, but when the resistance of the lamp is one hundred ohms or more the leading wires can be very

small as they will then be a small factor in the total resistance of the lamp, and will not heat so as to crack the glass. Lampblack which has been placed in sealed crucibles and subjected to a white heat for several hours may be kneaded with tar until it reaches such a consistency as to allow of its being rolled out on flat plates to very thin wires which are sufficiently flexible to allow for coiling into helices. After they are rolled out to the proper length and size they are coated with a non-carbonisable powder or liquid and wound or coiled. The two ends are increased in size and secured to platinum wires; the whole is then subjected to heat in a closed tube, and the volatile constituents of the tar driven off and the balance carbonised, thus making a solid and homogeneous coil which can be then united to the leading wires of the lamp and a glass bulb blown over it and exhausted of air and the lamp is then ready for use. The non-carbonisable material prevents the spirals from touching each other, until the whole has so stiffened sufficient to remain in its position. To assist in more rapidly manufacturing these spirals, I sometimes wind the flexible carbon wires between metallic spirals, which after the carbonisation of the tar are eaten away by acids, thus leaving the carbon intact. I also sometimes roll a thread within the compound of carbon and tar so as to allow of greater convenience in handling the same and the flexible carbon filament is not so liable to crack by its own weight in the act of winding. To increase the resistance of the lampblack-tar compound, I sometimes work into it a volatile powder such as powdered camphor, oxide zinc, but to make the light insensitive to variations of the current, a considerable mass of matter should be used in order that the specific heat of the lamp may be increased so that it takes a long time to reach its full brilliancy and also to die away slowly. To do this it is better to have the carbon as homogeneous as possible, and obtain the requisite resistance by employing a filament several inches long and winding the same in a spiral form so that the external radiating surface shall be small." Sir Richard Webster then passed to the complete specification of Edison's patent, which he read through, explaining various points to his Lordship. Proceeding, he said Mr. Edison was a skilled inventor and acquainted with the English patent law as well as the American; therefore he knew perfectly well that he might claim, and was entitled to various points of novelty, provided he claimed them distinctly. The carbon filament was a thing which he intended to claim and protect. In all his claims this special mode of coiling the carbon filament was a thing he meant to claim independently of the other use to which the carbon filament was put. The special mode of attaching the carbon filament to the platinum was also another thing which he meant to claim, and there were two combination claims which were independent of the shape of the filament and independent of the mode of attachment. The first is an electric lamp giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires as set forth. That was the novelty of this carbon filament. He was by no means sure that that claim might not be infringed by using that combination even where there was nitrogen gas inside the receiver. If his Lordship took one of the lamps and knocked it against his hand he would see that the filament would vibrate like a tuning fork for several seconds. That was of the greatest importance, having regard to the stability of the electric lamp for practical purposes. The advantage gained was in having lamps which might be put in railway carriages and places even near the traffic of streets, where the filament would be shaken but would remain unbroken. In addition to that there was the capability of shaping the bridge before carbonisation. In other words, the idea of shaping the conductor first, and then carbonising, was the root of the discovery which led to the success of Mr. Edison's lamp. Then the first claim also included securing the metallic wires; the second claim was a claim pure and simple to a carbon filament and a receiver, a glass through which the leading wires passed. That was in order to hit at people who said: "We do not use your particular platinum conductor; we have got other conductors, which we take up to the carbon filament." The third claim was as to the special coiled filament or strip arrangement, so that only a portion of the surface of the carbon conductor radiates; and the fourth was a method of securing in the carbonising chamber—carbonising the whole so as to get the close contact between the carbon and the platinum in the way described in the body of the specifications. Proceeding to the question of the anticipations, Sir Richard Webster said the defendants were advised by the most able counsel possible in this case, but he had never seen a case in which there was a greater abuse of the right or privilege of filing particulars of objections, for no less than 75 anticipations of Mr. Edison's lamp had been discovered by the ingenuity of Mr. Macrory and those who assisted him; and upwards of fifty of these had not the slightest reference to the matter. He would endeavour to state to his Lordship the leading landmarks of the invention prior to the date of the Edison patent. Before 1845 Mr. Justice Grove described a practical reading lamp formed by raising to a condition of illumination or incandescence a platinum wire on his table, and he (Sir Richard Webster) thought that Mr. Justice Grove had got quite as far in the year 1843 as a great many gentlemen afterwards got. About the time people began to see that carbon conductors were likely to be the sort of things that would do for electric lighting some day; and a man of the name of King in 1845 described a lamp which consisted of a carbon conductor, a stick or something of that kind, and in a Torricellian vacuum. It failed for various reasons, and among other reasons the vapour of the mercury which acted on the carbon, and no doubt the vacuum was not so

perfect in practice as it was supposed to be in theory. From that time anybody could claim carbon conductors, and only some special mode of combination could be claimed. Then people found that the air in the vacuum very soon destroyed the carbon, and the lamp would only burn for a few seconds. Then came the platinum wire lamps, and notably a very remarkable discovery by Mr. Edison in 1879, whereby a platinum spiral in a very high vacuum was raised to a condition of incandescence. In his specification 2,402, of 1879, Mr. Edison disclosed things with regard to the making of a vacuum which had an important bearing on Mr. Swan's subsequent patent, and upon which he was free to admit an attack would be made on Mr. Swan's patent. Then Mr. Lane Fox, a gentleman who did a great deal of research and invention in this country, discovered that high resistance lamps were more likely to succeed than low resistance, and he devised a number of clever means of mixing up non-conducting material with conducting material, as for instance, asbestos with carbon, for the purpose of increasing the resistance of the bridge across, but he wholly failed to hit upon the idea of the carbon filament, or a thread which could be made into shape previous to its being carbonised. So far as the prior knowledge was concerned, that was the condition of matters, boiling down the whole of the 75 anticipations. There was one other thing which was certainly very remarkable, and one very near in some ways to be a great discovery. He believed he held in his hand the only lamp, in respect of which, so far as he knew, it might fairly be said that Mr. Edison's statement of knowledge was incorrect. Mr. Edison thought a sealed glass bulb was entirely new. Some time in the year 1878 Mr. Swan exhibited this lamp at Newcastle. So little importance did he attach to it as a practical lamp that he did not patent it, and it never went further than this experimental lamp, and although in one sense a step in discovery, it was open to serious objections. It was the nearest approach to Edison's lamp which could be suggested. It consisted of a carbon pencil, a piece of carbon sweated or rubbed down to a thickness of something like the 32nd of an inch, a rigid piece with no flexibility; no power of being bent into shape prior to carbonisation, and having, also, the great disadvantage of requiring very large leading wires to go through the lamp, which would inevitably have the defects Mr. Edison pointed out. It was not practicable; it was not Edison's at all; it was not the carbon filament. He admitted there was a sealed glass bulb round the carbon pencil or stick; and Edison stated that he thought the glass bulb had not been used. But it had often been pointed out that an erroneous statement of the state of knowledge did not invalidate a patent. With regard to the vacuum Edison probably thought, and was right in thinking, that when you had such an extraordinarily attenuated filament as he described, the air shut up in the filament itself might be disregarded; but he discovered, in common with other people, that these conductors did contain occluded air, and in the earlier patent already mentioned, in describing a platinum lamp, he said you can improve your vacuum by passing an electric current through the platinum before the exhaustion is complete, which will drive out some of the air in the vacuum, which air will again be driven out by the exhaustion; then you can pass another current through and drive out some more; you can then finally seal your bulb. It is quite true Edison did not describe in this specification the mode of driving out the air from the carbon filament, nor was it necessary, because he has not claimed any special mode of manufacturing his vacuum. He could not say whether Mr. Swan actually re-invented the whole invention; very likely he did; but he certainly found out that in carbon lamps made as he described the fault was the occluded air which lowered the vacuum after the current was sent through, and accordingly he patented an improved method of making the vacuum. On page 2 of Swan's specification, No. 18 of 1880, he said: "It is well known that in that class of electric lamps in which light is produced by the incandescence of a carbon conductor contained in a closely sealed globe or glass, more or less exhausted of air, two difficulties have hitherto impaired their utility. (1st.) The carbon conductors in process of use gradually wasted, and ultimately broke. (2nd.) The interior surface of the globe containing the incandescent carbon became coated with a carbonaceous deposit, and obscured the light. I have discovered the means of avoiding both these faults, which are dependent the one upon the other, as follows, that is to say: I have found that if the globe, or vessel of glass containing the carbon to be rendered incandescent, be exhausted of air to a high degree of exhaustion, by means of a Sprengel pump, whilst the carbon contained within it is raised to the same, or a brighter degree of incandescence, as that ultimately required to be produced in using the lamp, and if the lamp be hermetically sealed whilst exhausted of air, under the conditions specified, the lamp so prepared is durable, both the faults above-mentioned eliminated, the incandescent carbon enduring without waste, and the interior surface of the glass globe keeping free from carbonaceous deposit." The point of weakness about this patent was that it was not confined to the filaments only. "In carrying out my said invention I take a rod, filament, or lamina of carbon, and a length and thickness proportioned to the current to be employed in heating it; for example, it may be two inches in length and 1-50th to 1-100th of an inch in sectional area. This rod, filament, or lamina, I clip at its extremities by means of a pair of platina clips, to which are attached platina wires, which serve for conducting the current through the lamp." There was some little difficulty in saying whether he meant filament in the same sense that Edison did. There was nothing to indicate that he meant a thread which could be carbonised after it had been shaped, or anything of that kind. The words, "rod, filament, or lamina" together, looked as

if he was using them independently of their particular form, but he thought he was right in saying that he contemplated something there more than was made before. He was free to admit the word "filament" did not occur in the claim. On the other hand he thought he was justified in pressing that it was a claim to a combination lamp in which the carbon has been exhausted in the way specially described. Mr. Swan's specification was filed on January 2nd; Mr. Edison's was not known to the world until April 10th, therefore there was no publication in England of Edison's invention prior to the January 2nd. A point arose on this which had never yet been decided. Where there had been a provisional specification published and no patent is taken out upon that, that provisional specification is not a publication of the invention, so as to anticipate a subsequent invention, if that subsequent invention was described within the period of six months while the provisional specification was secured. But in this case Edison's patent went to seal, formed the subject of a grant by the Crown, and therefore the question arose as to whether or not there could be a second grant for that same invention. The point had never been decided, but it had been discussed and touched upon in one or two cases.

MR. JUSTICE BUTT: I do not quite see the bearing on this point. You are here on the two patents. Is the point this, that if they get rid of Swan because he had been anticipated by Edison, then it is no use to say it is a joint patent?

SIR RICHARD WEBSTER: It is not joint; it is separate. I am only showing that they will say if we can bowl over Edison they hope to bowl over Swan.

MR. JUSTICE BUTT: That is to say, if we bowl over Swan by Edison.

SIR RICHARD WEBSTER: No! They only get rid of Swan; but still it is of importance to get rid of that as well. They desire, if they possibly can, to be free to work without paying a royalty upon Swan's patent. What the defendants say with regard to this particular specification of Mr. Swan is that Edison by his patent, No. 2,402 of 1879, showed you how to perform an analogous operation with regard to platinum, and also said that a carbon stick may be treated in the same way. My answer is that Edison was doing it for the purpose of improving his platinum as material, that he was not pointing in any way to the same thing, and further than that, it will be for your Lordship to say whether or not the description of Mr. Swan, applicable to the carbon lamp, is anticipated by that general description of knowledge, remembering that Edison was not contemplating a carbon lamp but a platinum lamp. And I think your Lordship will be satisfied by the evidence that it by no means follows that because it was a prudent thing to drive the air out of a filament or wire, it was equally prudent to drive it out of a platinum filament or wire. It might have had just the effect of making it friable or bad. On that nobody could say the one thing was a disclosure of the other. Sir Richard Webster then proceeded to describe Gimson's patent. Gimson took his platinum terminal sheet and flattened it out until it assumed the shape of a spade. Then he turned it round through a die or mandrel, until it assumed the shape of a tube. Into that tube he dropped the end of his carbon filaments, and by the combined spring of the carbon and metal tubular parts the carbon is held firmly in place in the said terminals. Then he claimed improvements in electrical lamps consisting of attaching the carbon of the terminals. He had now described all three patents, and he thought he might say that, except so far as putting a proper construction upon Edison's specification, the infringement in the ordinary sense of the word would not be denied.

MR. CHARLES: I cannot admit that.

SIR RICHARD WEBSTER: I do not ask you. I said I think it will turn out that, assuming the patent to be good and to have the construction for which I am contending, the infringement will not be denied. We have the glass bulb, we have the carbon filament, that is to say, this thread or thin strip of wood. The particular Edison lamp which I have handed up is made in one of the ways indicated in the specification, of a piece of bamboo, finely divided and then carbonised. Lastly, I believe it will turn out that the attachment between the carbon and the platinum is made by making a formation of the end of the platinum, twisting it round, and inserting the pieces of carbon. We have broken several of the lamps, and we find they were constructed in that way, and I do not think that will be disputed. Sir Richard Webster then said that as he did not intend to trouble his Lordship with another opening upon the second case, and as it would be necessary to consider the patent upon which the second action was brought, he might as well tell his Lordship what it was now. Cheesborough was the man who took out the patent, but it was discovered by Messrs. Sawyer and Mann that the carbon might be very much improved for electric purposes if it was subjected to a certain treatment; that was, if it was put into a hydro-carbon gas or liquid and then an electric current passed through it. That had the effect of consolidating or making uniform the structure or substance of the carbon which formed the conductor, and that particular invention consisted in improving the material of the carbon itself, partly by deposit and partly by some other action, by inserting it in a hydro-carbon liquid or fluid, and by passing the electric current through. When they came to that part of the case they would assert that they had as to that a distinct admission that those carbon filaments, after having been made in the way described, had been subjected to that treatment by the defendants. He mentioned that now in order that his Lordship might understand that he had said enough for the purpose of indicating the four rights in respect of which the two actions were brought, although he quite agreed

they must be fought separately. I think your Lordship will be of opinion, when you have heard the evidence in this case, that, subject to the one somewhat difficult question so far as affects Mr. Swan's patent, there is no doubt, at any rate upon the other two patents, and I shall submit on that also, that the plaintiffs are entitled to recover.

SIR FREDERICK BRAMWELL was then sworn, and examined by Sir Richard Webster. He said he had studied the matter of electric lighting for a long time, and had become acquainted with the various lamps and improvements brought out from time to time. In Edison's specification No. 4,576 of 1879, he found a vessel made entirely of glass containing a carbon filament attached to conducting wires, which wires are sealed through the glass. This vessel is to be exhausted of its air to a very great degree, the patentee mentioning that only one millionth of an atmosphere might be left. The patentee says with a lamp of that construction light can be obtained by rendering the filament incandescent by means of an electric current. The specification contained different descriptions to enable a competent workman to construct such a lamp. The advantage of a lamp made with a filament was that you are enabled to get an extremely high resistance where you desire it, that being advantageous for the purpose of incandescent lighting by multiple arc. Having described the method of lighting by multiple arc, and the system of arc lighting, Sir Frederick Bramwell stated that this patent related solely to the incandescent light. According to the specification the filament was to be made before carbonisation, and a variety of ways were described in which it might be formed and then carbonised.

Would you tell my lord what are the advantages or the necessities for the particular combination of coiled filament, the subject of the third claim, which Mr. Edison refers to as being desirable when there is an unsteadiness of the current?—Mr. Edison there is pointing out that by adding to the quantity of the filament you have, as it were, a species of reservoir which will neither so rapidly increase its glow nor so rapidly lose its glow as when there is a less quantity. Then he says you cannot get that quantity by having it in a straight wire, because if you did, you might probably not get heat enough; but if you coil it, then the internal reflection of the coil from one side to the other prevents that part from being a radiating surface in the ordinary sense, and in that way you can get this greater length and greater resistance, and what I may call greater capacity.

He says that if the current is unsteady the result is that you will have steady light, and if the current is steady you do not require this coil?—Yes; he says at page 4, line 38, that if the current is steady the defect of the rapid appearance or disappearance, does not show.

As a matter of fact are these lamps with the plain filament equally effective for the purpose of lighting?—Yes. The wire nearly bent going out and back again.

As far as you know was the combination described in Mr. Edison's specification new?—So far as I know. I have gone through the suggested anticipations, and so far as I have gone I have not overlooked anything. I do not find anything in them to anticipate the plaintiff's lamp as I have described it.

Is carbon well-known as a conductor of electricity?—Yes; all arc lights depend upon that.

For how long had attempts been made to utilise carbon in one shape or other in connection with incandescent lighting?—1845 was the earliest that I know of. A man named King had a sort of barometer tube with an enlarged part at the top; a wire led in through the glass top, an attachment to a stick of carbon, and a wire led out through the mercury at the bottom, and on this tube being put upright the mercury fell, and left the upper part in a vacuum as condition as the Torricellian vacuum can produce. That was publication of the use of carbon as an incandescent conductor. Attempts had been made to get rid of the perishing of the carbon, or other conductors, by the action of air inside the bulb by replacing atmospheric air by some gas which would not combine with the carbon, and would not burn it. So far as I remember at the moment the experiments were all made in nitrogen.

Had other conductors than carbon been used in incandescent lamps?—Yes, platinum and an alloy of platinum and iridium. No practical electric lamp that has ever survived in commercial use has been introduced with such conductors. But I have seen lamps of that kind at work, and I believe before the date of the patent I have a distinct recollection of seeing them at work at a soiree of engineers held at South Kensington a good many years ago; I think before 1879. There is no doubt you can raise platinum to incandescence. But since the carbon filament was described it has had the monopoly.

So far as resistance was concerned had Mr. Edison and Mr. Lane-Fox pointed out the desirability of high resistance?—Mr. Lane-Fox had pointed out the desirability of high resistance.

Taking the Swan Newcastle Lamp, exhibited before the date of Mr. Edison's patent, will you tell us what that is so far as you can examine it without breaking it?—It is obviously glass. There are two large wires sealed through the two ends of the lamp, which from their appearance are platinum. There are the remains of a tube that has been finished off by the glass-blowers. There is also a globule of mercury in the lamp, and both these ends are consistent with this lamp having been exhausted by a Sprengel pump. Of course I cannot tell unless I break it that it is in a vacuum condition; I have no doubt about it. There is a little globule of mercury that has got in from the Sprengel pump, no doubt. In between these two wires there is what I should call a pencil of carbon; I cannot tell you the exact diameter, but it is a very appreciable fraction of an inch. It lies

rigidly between the ends of the two conducting wires, and is in my opinion in no sense to be called a filament of carbon.

Just look at the two ends of that carbon or pencil. Are they thicker or the same diameter just above where they join the platinum?—I think they are the same diameter, but there is something of a larger diameter, which, however, I believe to be a piece of metal.

I think by the magnifying glass you could see the platinum wire as it comes on to the carbon?—I have seen it.

I do not know whether you can tell from the view whether that has been worked down from a thicker piece of carbon or not?—I have no doubt it has. The appearance is quite consistent with that. That would be a lamp of low resistance. The carbon is of great sectional area.

You have already said that that carbon pencil is not in any sense, in your opinion, a filament of carbon?—Yes. Mr. Edison has told you that that which he wants can be obtained by a mere thread, an absolute thread carbonised, and when he comes to that kind of filament that he proposes to make out of the sort of paste he tells you that it is to be $\frac{1}{1000}$ ths of an inch. This, I should say, would be more like a 22nd or 24th, judging by the eye.

Have you ever seen a lamp of that kind in commercial use, or burning at all?—Never. So far as I know it has never been used experimentally, except by Mr. Swan. I know by the particulars of objection that one of them was broken up by a gentleman of the name of Proctor, who gave a lecture on what he called the smoke inside an electric lamp. He wanted to break it up in order to discover what the smoke was composed of.

Do you believe that any of the publications or disclosures were commercially practical in incandescent electric lamps before December, 1879?—None of the carbon ones certainly. The metallic ones for a long time appeared as though they were about to be successful lamps. When the solution came of the carbon filament I think they had all been practically dropped.

Has the carbon filament been of great practical use, and largely adopted?—Yes; it is in use over your heads at the present moment.

I will just ask you to describe that part of the Swan patent which deals with the question of getting out the occluded air in the carbon. What are the causes which lead to the longer or shorter life of the lamp, so far as vacuum is concerned?—Two. One, the combination of the oxygen of the air with the carbon, really burning it away to the extent to which there is air there. The other is that which is generally known now, I think, as the washing of the carbon, the absolute friction and attrition of the circulation of the air due to the difference of temperature in the different parts of the lamp. The effect of passing a current through, then exhausting, and then sending another current through is that the carbon and the vacuum together drive out from the carbon any occluded gases and the vacuum being continued at the time removes them, and then after they are removed the lamp is sealed. That improves the light of a carbon lamp.

What was known, as to driving out air, prior to 1880? So far as I know the thing that was known is to be found in a prior specification of Mr. Edison, No. 2,402, page 437. Mr. Edison is speaking primarily there of one of the platinum iridium incandescent lamps. At page 9 of the final specification, line 33, he says:—"From my researches and experiments I am led to believe that the cause of the rupturing of the metal when brought to incandescence is due to the action of the gases contained in the pores of the metal. These gases are probably compressed within the pores directly during the rolling or drawing of the sheet or wire. These gases or air when subjected to a high heat are greatly expanded and rupture the metal, and cannot be driven out only by slowly heating the metal." Then he says: "I have also discovered that the loss of weight and apparent volatilisation of the metal is due to the action of the air or gases against the highly-heated surface." That includes his washing of platinum iridium wire. Then he says that having ascertained the causes of these defects, he set himself to cure them; and then follows the description: "A spiral of platinum wire is placed in a glass bulb with its ends passing through, and sealed in the glass, and the air exhausted from the bulb by a Sprengel pump until the discharge from a three-inch induction coil will not pass between two subsidiary wires in the bulb, the ends of which are 4 millimetres apart." The power of the electric spark to pass through a given distance is used as a test of the vacuum. Then he says: "The wires of the spiral are then connected to a magneto-electric machine or battery, whose current can be controlled by the addition of resistance. Sufficient current is allowed to pass through the wire to bring it to about 150° Fahr.; it is allowed to remain at this temperature for 10 or 15 minutes. While thus heated the air or gases in the pores of the metal are expelled by the action of the heat and the expansion of the gases which tend to pass outward of the vacuum." Then he says the mercury pump is kept continually working. At the end of 15 minutes he raises to 300° Fahr., and he waits for another 10 or 15 minutes, and so he goes on until he raises it to a dazzling incandescence, a light of 25 standard candles. "Whereas before treatment the same spiral would only emit a light equal to three candles before attaining the melting point." Then he says at line 10 on page 10: "The wires subjected to the process of freeing them from air or gases are found after the process to have a polish exceeding that of silver and obtainable by no other means. No cracks can be seen even after the spiral has been raised suddenly to incandescence many times by the current, and no volatilisation takes place, as there is no deposit upon the glass bulb, nor does a delicate balance show any loss of weight in

the spiral even after such spiral has been burning for many hours continuously, because the spiral is in a vacuum so nearly perfect that the action of the gaseous molecules is reduced to the minimum, and were it possible to obtain an absolute vacuum there would be no loss whatever."

(To be continued.)

NOTES.

Bank Lighting.—The new premises of the English Bank of Rio de Janiero, Moorgate Street, which have lately been occupied, are lit on the Electrical Power Storage Company's system by 50 incandescent lamps. A 4 H.P. new type "Otto" gas engine drives a dynamo which charges 31 of the 15 L cells in glass boxes; the whole installation being in the charge of the hall porter, as in the case of the New South Wales Bank. Both these instances show conclusively, were such proof required, that if the installation is properly put down and carefully arranged, there is no necessity whatever for having skilled labour to work it; and further, that a gas engine can be put down in the busiest thoroughfares without any risk of causing annoyance to the neighbours.

The Electric Light in Carriages.—The success of the incandescent electric lamp for private carriages in Paris is pronounced complete. The lamps are connected by wires with small storage batteries under the drivers' seats. They are small in size, being only about eight inches square and four inches high, each of the batteries being capable of supplying a lamp of 5 candle-power for a period of some six hours. During the day they are removed and charged, and at night they are ready for use.

Investigating the Electric Light in Darkness.—Mr. Justice Butt, who is trying an important incandescent lamp patent case, must have been strongly impressed with the truthfulness of counsel and witnesses on Tuesday when they spoke of the safety and reliability of electric lighting by incandescent lamps, for, as a commentary upon the statements made, about an hour before the usual time of adjournment the incandescent lamps with which the Court is lighted suddenly ceased to give light. There was just enough daylight left to enable the Court to adjourn without danger, but not enough for the continuance of the sitting. Mr. Moulton, in response to some bantering remarks, explained that the breakdown was not due to the lamps at all, but to the machinery, or perhaps to some vagary of the engineer. The lamps in the corridor outside the Court remained alight, so it was evident the collapse was not general throughout the building. We would advise more care and greater supervision in the electric light department at the Law Courts.

Leeds Town Council and the Electric Light Bills.—The Leeds Town Council last week resolved to petition Parliament in favour of the Government Electric Lighting Act (1882) Amendment Bill. Alderman Emsley, in moving the resolution, said he did not think that Leeds was now very dependent upon any electric company with regard to the electric light. Its hydraulic powers would give Leeds a position which no other town in the United Kingdom would have. All that a shopkeeper or householder would have to do when the Compressed Air and Hydraulic Power Bill was passed was simply to have a dynamo, all power being furnished at a very reasonable price. He did not think that companies would have any chance of profit in coming to Leeds, except in the way of selling their dynamos.

The Albert Palace Lighting.—Our expectations have been verified as to the electric lighting of this palace; the contract has been given by Mr. Holland to the Jablochkoff and General Electricity Company, which gave him such satisfaction at the Covent Garden Circus.

The Uses of the Telephone.—A few weeks ago we spoke of the adaptation of the telephone as a means for indicating the results of the shooting at rifle ranges. The Western Counties and South Wales Telephone Company has recently supplied the Brownsdown ranges with telephonic arrangements, and the company's Portsmouth District Superintendent, Mr. J. H. Sandy, has just made a report upon the system. It is addressed, under date May 8th, to Mr. H. F. Lewis, the general manager, and reads as follows:

"Mr. Hovell's Experiments at Firing Ranges.—I visited Brownsdown ranges yesterday, with the desire, and by appointment, to see the working of the telephone for the purpose of the marker giving the result of each shot by telephone instead of by flag signalling. I was in the signal hut over an hour, and I must say that the result was all that could be wished. The advantages appear very great over the old system. In the first place, the click of the rifle could be distinctly heard, which prepared one to watch the target for the mark, and thus relieved your eyes from the constant watching of the white glaring target. Again, the man can give the actual result of each shot, whether to the right, left, above, below or a miss, and give the *exact* result, whereas the flags could give but very imperfect information. Mr. Hovell was much pleased to see me, and fully explained the improvement to me. He thinks that ultimately the system will be universally used, and he will continue his experiments with this object."

We may add that the arrangements for the Brownsdown ranges are similar to those supplied by the same company for the diving experiments in connection with the use of the telephone on board H.M. ships *Vernon* and *Excellent*, and which have been so successful that they have been generally adopted for diving purposes.

Free Telephonic Communication.—The Western Counties and South Wales Telephone Company, who are about to establish an exchange at Southampton, have undertaken to connect with their system in that town the principal police-station, the fire brigade headquarters, and the infirmary, free of charge.

Telephone Tariff Charges.—The National Telephone Company, Limited, with the view of increasing the telephone facilities to subscribers and the public, has resolved to modify its existing tariff for exchange, private, and Trunk wires. List of subscribers and full particulars may be obtained at the offices of the Company, 13, Royal Exchange Square, Glasgow.

Telegraphic Communication Wanted.—The apparent likelihood of a European war should draw the attention of the Admiralty to the desirability, not to say necessity, of establishing a line of telegraphic communication with Bermuda, which appears to be entirely isolated. At present the quickest communication is from New York, and occupies 50 hours in transit. A Gibraltar correspondent says that the people of Ceuta are complaining bitterly that although plans have been matured for the last five years to connect that town with the peninsula by submarine telegraph, nothing has yet been done. Tangiers is more favoured.

Presentation of Medals to Telegraphists.—On Saturday, at the close of the annual inspection of the Queen's Edinburgh Rifle Brigade in the Queen's Park, by Colonel Macpherson, C.B., five telegraphists were presented with medals for serving in Upper Egypt and the Soudan. The names of the men were Andrew Isles, Daniel Thomas, Charles E. Gray (Upper Nile), and Thomas Smith and R. W. Newlands (Suakim). The presentation was made by Mrs. Cunynhame, wife of the Surveyor General for Scotland. The number of Volunteers on the ground was 2,196, under the command of Colonel J. H. A. Macdonald, M.P.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to May 8th, 1886, amounted to £135,000 against £140,000 received from April 1st to May 9th, 1885.

Non-Delivery of Telegrams.—Mr. Forwood asked the Secretary to the Treasury in the House of Commons, on Monday, whether the refusal of the postal authorities in Liverpool to deliver a telegram sent from Oswestry on the 16th of April, addressed "Pierce and Hartley, Solicitors, Liverpool," and one sent on the 20th of April, at 10:37 a.m., from Coniston, addressed "Thornley and Cameron, solicitors, Liverpool," on the ground that "the delivery could not have been effected without reference to a directory," complied with the latest instructions of the Postmaster-General in reference to the delivery of telegrams. Mr. H. Fowler: Although it is open to doubt whether in the cases referred to the senders had "done their best to give a sufficient address," the Postmaster-General thinks that the addresses given were sufficient to insure the delivery of the telegrams, and renewed instructions on the subject have been given.

The West India and Panama Cable.—In renewing the subsidy of the West India and Panama Telegraph Company, the discussion in the Demerara Court of Policy turned upon the defective state of the cable, the meagre and uncertain character of the information sent, the enormous charges made by the company for the transmission of messages, and the expediency of enforcing the penalty for interruptions. The discussion was rather warmly maintained. The Attorney-General said he thought there should be a line of telegraph communication between Great Britain and the West Indian Colonies, passing through the dominions of Great Britain; that this had apparently been recognised by the late Home Government in offering a subsidy for a line of cable from Halifax *via* Bermuda to Jamaica; and that if that were done there could be no doubt the Colonies themselves would lay down their own line to connect Jamaica with the other West Indian Islands.

Another French Atlantic Cable.—The *Daily News* Paris Correspondent telegraphed last week that M. Granet, the Minister of Posts and Telegraphs, had granted a charter to a French company for laying a cable between Brest and New York, *via* Guadeloupe. All the directors were to be French, and it had been stipulated that the cable was to be manufactured in France and laid by French vessels. An important clause in the contract was that the State will guarantee a certain interest on the capital. In this matter the *Daily News* Correspondent is not quite correct, as foreign firms are admitted to tender for the proposed cable.

Another Fracture of the French Atlantic Cable.—The French Cable Company, having ascertained that one of the cables has parted some 30 miles off Lands End, has sent a steamer to repair it. The steamship *Lady Carmichael* arrived at Penzance on Saturday night, and left the following day for the scene of the rupture.

How are the Mighty fallen!—We hear that the ss. *Great Eastern* has been secured by Messrs. Lewis and Co., of Liverpool. The vessel will be moored in the Mersey, and used for exhibition purposes afloat. It appears to us that the only difference between her present and past career is that instead of, as now, being made an exhibition of by others she previously made exhibitions of herself. Be this as it may, we learn that she is to be electrically lighted throughout, and that the work is to be carried out by the Jablochkoff Company.

The Delany Multiplex Telegraph.—In reply to several enquiries respecting the publication, last week, in a contemporary, of a guide to the English Postal Telegraph officers for fixing and working the Delany telegraph, we are enabled to say that the directions therein given have been subjected to very considerable modifications, and that the guide may therefore be considered more or less obsolete.

Technical Electrical Apparatus.—In the course of his lectures on science teaching, at the Society of Arts, Prof. Guthrie gave the following particulars of his mode of procedure in regard to electricity:—"The principal pieces of apparatus constructed in this branch are:—A gold leaf electroscope; a differential condenser; a sand-dropping accumulator; a Leyden jar; an electrophorus; a dry pile; a voltaic cell; a differential galvanometer; a resistance bridge; a set of resistance coils; a tangent galvanometer; a potentiometer; a thermo-element; a thermopile. And by these apparatus typical experiments and measurements, of which the following are a few, are made:—The study of magnetic curves; the action of the current on the needle; the relation between length, weight, and resistance in wires; the effect of temperature on resistance; the law of divided circuits; specific resistance; electromotive force; internal resistance of cells, and so on. Electricity, especially voltaic, lends itself perhaps more abundantly to exact measurements in the elementary laboratory than the other branches, and it is on this account, and because it is the last subject treated of, and so claims any spare time at the end of the term, that it occupies a rather prominent part. I do not hold that it has really any greater educational value than the other branches, and certainly in a general educational course it is not for me to give it prominence, because just now it has a considerable technical development. I trust the time may never come when any branch of physics will be considered as of comparatively little importance in general education. Excepting as to the subjects of mining and metallurgy, our schools are without technical training."

Electric Street Cars.—Of all the newspapers which have ever reached this office, from whatsoever clime they came, the *Independence Sentinel* is by far the most remarkable for the inaccuracies which it contains. Scarcely a paragraph but contains glaring typographical or grammatical errors. Perhaps, therefore, it was the best receptacle for a paper on "Electric Street Cars," which was recently read before the Query Club of Kansas City, and reported in its columns. The character of the paper may be gathered from the following extracts. It commences: "An examination of the history of human progress should incline us to be astonished at the stupidity rather than at the achievements of the intellect of man." . . . "Two difficulties have stood in the path of success from the first, and were not thoroughly overcome until our townsman, Mr. John C. Henry, set his wits to work about it. One of these difficulties was to convey the current to a moving car and yet not waste it or make its use perilous to street travel. Some inventors used the sails as conductors, others placed conductors in conduits beneath the cars; others carried accumulators in the cars, others used tubular over-head conductors slit throughout for the introduction of a brush; in all of these the method is either wasteful and inadequate or extremely expensive. It was reserved to Mr. Henry to suggest over-head wires with a little wheeled contact carriage to travel along them and transfer the current to the car. By this simple but perfect device one of the bug-a-boos of electrical locomotion is destroyed."

Information Wanted.—We understand that the *Volta* is engaged in picking up the old Direct Spanish cable between Bilbao and the Lizard. It would be interesting to know if there is any connection between the work on which she is occupied and the recent breaking of the Atlantic cable which the *Lady Carmichael* has been sent to repair.

The Price of Descriptive Articles.—Mr. W. H. Forbes, president of the American Bell Telephone Company, told the Telephone Investigating Committee of the House that the *New York Times* was paid \$1,200 for publishing on the 1st of January last a four column news article about the development of the Bell telephone.

New Electrical Generators.—The construction of electrical generators of the type advocated by the Hon. Charles A. Parsons, suitable for use on board ships where lightness, compactness and simplicity were of the most importance, has, we learn from the *Mechanical World*, been carried on at the Victoria Works, Gateshead-on-Tyne, by Messrs. Clarke, Chapman, Parsons & Co., and the largest sized generator made by them has run at a speed of 9,000 revolutions per minute with 50 lbs. steam pressure, giving a current of 200 amperes with an electromotive force of 80 volts. On several occasions with this load this generator had run for several days without stopping. The generator consisted of a compound turbine motor, coupled directly to the armature of the dynamo; both were mounted on bearings of special construction, and were lubricated automatically and continuously. The speed was governed by a combination of fan-governor and subsidiary electrical control, which kept the electromotive force to within one volt of the normal pressure. The magnets are shunt-wound, and take about three amperes of current, and the armature is one of very low resistance. The total weight of this generator is 15 cwt., and the steam consumption per electrical H.P. is given as being very moderate.

The British Association.—The programme of arrangements for the Birmingham meeting of the British Association has just been issued. It meets on Wednesday, September 1st, when Sir Lyon Playfair resigns the presidency, which will be assumed by Sir William Dawson, C.M.G., F.R.S., the eminent Canadian geologist, Principal of McGill College, Montreal. In the permanent staff there is no alteration, except that the new secretary, Mr. A. S. Atchison, assumes full responsibility for the first time in place of Prof. Bonney. The following are the presidents of the various sections:—A, Mathematical and Physical Science, Prof. G. H. Darwin, F.R.S.; B, Chemical Science, William Crookes, F.R.S.; C, Geology, Prof. S. G. Bonney, F.R.S.; D, Biology, William Carruthers, F.R.S.; E, Geography, General Sir F. J. Goldsmid, K.C.S.I., C.B.; F, Economic Science and Statistics, John Biddulph Martin, F.R.S.; G, Mechanical Science, Sir James N. Douglas, M.I.C.E.; H, Anthropology, Sir George Campbell, K.C.S.I., M.P. On Thursday evening, September 2nd, there will be a *soirée*; on Friday, September 3rd, at 8.30, a discourse on "The Sense of Hearing," by Prof. W. Rutherford, M.D., F.R.S.; on Monday evening, September 6th, at 8.30, a discourse on "Soap Bubbles," by A. W. Rücker, M.A., F.R.S.; on Tuesday evening, September 7th, at 8 p.m., a *soirée*.

Electricity Analysed.—The author of a pamphlet bearing the above title has ere this figured in our notes columns. His name is William Boggett, *ætat* 90; he hails from Chelsea, and is best known in connection with some experiments of an interesting nature which he performed with the aid of his niece, to show that the electric state of males and females respectively is essentially an opposite one. Dealing in this, his latest production, with matters with which we have a more intimate acquaintance than with the above, this latter-day Chelsea sage thus learnedly proceeds: "Messrs. Gaulard and Gibbs have proved the great amount of electricity in the atmosphere by the large quantity they obtained from a dynamo to light several stations on the Metropolitan Railway being passed into the *primary wires without loss*, but went on without any diminution into the secondary wires, from which the supply of light was given to several stations on the line. The secondary wires, therefore, could only have received its lighting power by induction from the atmosphere." We should have been inclined to attribute the high percentage of return in the Gaulard-Gibbs apparatus to the employment of this atmospheric dynamo were it not for an admission made by Mr. Boggett, which somewhat shakes our faith in him. He candidly says: "As an uneducated man I deem it proper to apologise for advocating opinions directly at variance with those held by the highest scientific authorities."

Crompton Dynamo Tests.—A friend writes thus:—"Mr. Sydney F. Walker's letter of last week contains two serious errors regarding the working out of the results which require correction. First, the I.H.P. given to the exciter does not enter into the calculations as Mr. Walker suggests, and should *not* be added to the I.H.P. of the main engine, since the watts absorbed in excitement were included in the gross electrical output and deducted therefrom, thus leaving a nett electrical output on which to base the efficiency. The watts employed to excite the machine are thus included in the I.H.P. tabulated, and the method of arriving at the final results as printed in the report is correct. Secondly, by running the engine light and comparing the I.H.P. with that developed when fully loaded an *apparent* efficiency of the engine is given only, and not a *real* efficiency, since the work absorbed by friction is greater when the engine is loaded, and therefore does not accord with that obtained from the diagram taken when running light."

Cells for Accumulators.—That very considerable difficulty is experienced in obtaining outer cells for accumulators, which shall at the same time be cheap and durable, is well known. The only material which has hitherto proved satisfactory as regards durability has been glass, but cells of this substance are expensive. Porcelain has been tried, but we believe not with great success owing to the powerful effect which the acid solution under the influence of the disengaged gases has upon the material, the glazing becoming rapidly destroyed. Messrs. Price, Sons & Co., of Bristol, have recently introduced a highly glazed vitrified description of stone ware which is likely to prove useful for accumulator and other purposes. The makers guarantee that the ware shall last 12 months under the influence of the disengaged gases in accumulator cells. The durability of the ware is no doubt due to its high vitrification, which gives it the nature of glass. An improved form of insulator for supporting battery troughs is worthy of note; the upper portion of this insulator, on which the trough rests, is made of a mushroom form, and is larger in diameter than the base, so that any drip which may take place falls clear of the lower part of the insulator.

Electrical Works in the British Museum.—A catalogue has just been compiled at the British Museum comprising all the works acquired during the years 1880-85 in all modern languages except Oriental, Hungarian and Slavonic, arranged according to subjects. The subject "Electricity" is a remarkable one for the number of entries under it. They fill 10 pages in double columns, and about half refer to the electric light. Fifty telegraph codes were published in the five years, exclusive of innumerable private and cypher codes.

Electricity in the Royal Navy.—The *Dreadnought*, which has just arrived in Suda Bay after undergoing extensive repairs and alterations at Malta, has been fitted with a "Victoria" dynamo and incandescent lamps for internal lighting. The *Superb*, which has been conveying supernumaries and stores to the British fleet in Suda Bay, has been having target practices at night, by means of the electric light. From some cause or other, however, the latter was by no means so powerful as was necessary, and the experiments were not a success. The torpedo ram, *Polyphemus*, also at Suda Bay, has been practising signalling with her new mast-head semaphore, the *modus operandi* of which has already been touched upon in the columns of the ELECTRICAL REVIEW. The signals were read with great ease by the various vessels of the fleet, and the system was generally admitted to be far superior to that at present in vogue. As the apparatus can be easily fitted to the masthead of any ship carrying the electric light, the Admiralty would do well to lose no time in superseding the old method.

Wire Gauges.—Mr. Carl Hering publishes in the *New York Electrician and Electrical Engineer* for the present month a combined table of all the principal wire gauges used in America, England, and France. By the use of this table Mr. Hering thinks that many calculations become simplified, while others can be avoided. In the same journal the author contributes the second paper of a series on Dynamic Electricity.

Arc Lighting Plants.—If a man desires to erect an expensive house he generally consults an architect, and if you propose to go into the electric light business it is far more important that you consult and be guided by the advice of an electric light engineer. So says Mr. J. M. Offord, the superintendent of the Bridgeport (Conn.) Electric Light Company, who this month publishes in the *Electrician and Electrical Engineer*, of New York, the first portion of an article which promises to be of much interest and value, on "The Installation and Management of Arc Lighting Plants."

American Arc Lighting Industries.—The most favourable indication of the permanent prosperity of the electric lighting industry in America is the fact that it is quietly settling down upon the basis of ordinary commercial undertakings, and is now generally free from that artificial stimulus which was originally given it for the purpose of floating various speculative schemes. It appears now to offer inducements for the investment of a considerable amount of capital in the aggregate, which, under careful management, will earn a good profit. Once fairly established, a local electric lighting company advertises itself, and will secure customers, as it gradually evinces its ability to render good service.

The Queen's Visit to Liverpool.—Newsham House, which was occupied by the Queen during her visit to Liverpool this week, was lighted throughout by the electric light. The Electrical Power Storage Company's batteries were used for the purpose in the royal apartments, and a very successful effect was produced by the use of beautifully etched glass globes, the light being further subdued by light draped silk shades. The whole of the work was carried out by Messrs. Holmes and Vaudrey, of the Liverpool Electric Supply Company, Limited.

The Electric Lighting Bills.—A petition has been prepared by the Institution of Civil Engineers for presentation to the House of Lords. It recites that Bill No. 3 (Lord Houghton's) extends the time for purchase as per Clause 27 of the Electric Lighting Act, 1882, and Bill No. 2 ameliorates that clause to some extent, and states that capital is not likely to be attracted to an electric light undertaking, which must be one of development, extra capital being required as the use of the light is extended. No one would, however, be found "to embark money after the lapse of a few years, when the time of enjoyment was so much shortened." The petitioners therefore pray that Bill No. 3 may not be allowed to pass into law, but the Electric Lighting Act (1882) Amendment (No. 1) may pass into law, and that the Petition may be referred to the Committee now sitting.

The Electrical Transmission of Power.—We learn that MM. Rothschild Frères have rented very extensive offices at 13, Rue Lafayette, Paris, as head-quarters of the company formed by them for the purpose of offering the public the results of Marcel Deprez's experiments on the transmission of power by electricity. Opinion in Paris seems to be much divided as to the value of these discoveries from a practical point of view. On the one hand, we are told that for three months the receiving machines at the La Chapelle station (Chemin de fer du Nord) have been at work, and that the results of some hundreds of tests have shown work developed up to 30 and 50 H.P., representing a loss through transmission of 50 and 70 per cent. The motive power is situated at Creil, some 56

kilometres from Paris. We understand that a very favourable report on the scientific and commercial value of these experiments has been made by a commission of 38 members selected from among the leading personages in science and finance, and formed for the purpose of conducting an exhaustive examination of the work obtained from the machines at La Chapelle. During the experiments carried out by this commission, the receiving machines developed nearly 50 H.P., which was applied to the working of large hydraulic apparatus employed in the internal service of the station, and of winches, motors, hammers, &c., altogether forming an example of electrical distribution as applied to industrial purposes. A sub-commission has been appointed to draw up a complete and detailed report upon the results of the experiments so as to accurately determine the exact power developed and the loss through transmission. As opposed to this favourable report, the opinion of many scientific men is decidedly against the practical value of these discoveries. They affirm that Mons. Marcel Deprez has approached the subject on altogether a wrong tack, and that he is completely in error when he states that the loss of power through transmission is quite independent of distance, and that better results are obtained from small conductors than from large. They say that the figures given are not to be relied on, and in any case it is doubtful whether the results of his experiments will show any improvement on those already obtained by Mons. Felix at Cermaize, and by the director of the powder manufactory at Sévran. More than a million francs have been spent in these experiments which have yet to be reduced to some practical form, and it shows considerable courage on the part of MM. Rothschild to embark so largely on an enterprise as yet practically undeveloped.

International Railway Exhibition.—An International Exhibition will take place in Paris next year, when the railway jubilee will be solemnly celebrated. This exhibition will comprise the different industrial branches concerning railways, such as engineering, mechanics, signals, locomotion, apparatus for lifting, heating, lighting purpose, inter-communication, machinery, waggons for travellers and goods, models of improved railway wagon couplings and other railway appliances, building and conveyance material, furnishing, metallurgical trade, electricity, &c.

East of Scotland Engineering Association.—At the last meeting for the session of this association held last week in the Oddfellows' Hall, Edinburgh, Mr. A. C. Elliott read a paper on "Automatic Electric Railways," which gave rise to considerable discussion.

The Newest "Brush."—The *Age of Steel* has been informed that the Brush Electric Company of Cleveland, Ohio, is constructing what our contemporary incorrectly describes as the largest dynamo in the world. It will be 12 or 13 feet long, 5½ feet wide, and weigh 10 tons. The dynamo will give a current of 122,500 ampères at an E.M.F. of 2 volts. This machine will be used for the smelting of aluminum, in connection, we believe, with the Cowles electric furnace recently described and illustrated in the REVIEW. Five hundred horse-power will be required to drive it, which will be furnished by water with the aid of turbine wheels. The largest dynamo ever constructed is that designed by Mr. J. E. H. Gordon, and built by the Telegraph Construction and Maintenance Company. Mr. Gordon's enormous dynamo was illustrated and fully described in our columns for October 28th, 1882.

New Book on Electric Lighting.—Mr. A. A. Campbell Swinton has at present in the press a small book entitled "The Elementary Principles of Electric Lighting." It treats the first principles of the subject in the simplest possible language, and is intended as a primer for the use of workmen and unscientific persons, totally unacquainted with the rudiments of electrical

science, and as a stepping-stone to treatises of a more advanced and elaborate nature.

The Edison-Woodhouse and Rawson Case.—At the time of our going to press the Solicitor-General (Sir Horace Davey) had commenced his opening statement for the defence in this case. He submitted that the use of a carbon conductor in a sealed glass bulb was open to the world, King having in 1845 described the use of carbon for the purpose, and Swan having used a carbon filament in a lamp which he described at Newcastle in 1878. Edison merely used a finer conductor, and this did not constitute an invention; he claimed the method of manufacture in his specification, and not the material used. The importance of high resistance was described by Lane-Fox and Prof. Tyndall before the date of Edison's specification, both pointing out that in order to procure high resistance a fine wire or filament must be used.

Listening for an Electric Shock.—At the Thames Police Court, last week, Thomas Wackett, 28, was charged with being a wandering lunatic. At two o'clock on Thursday morning Wackett was seen wandering in Grove Road, Bow. He was watched, and Constable 225 K saw him lie on the tram lines and put his ear to the line, saying he was listening for an electric shock. He had his coat off, and, in answer to the constable, he said an electric battery was in his coat and he put it off. The doctor said that the prisoner was of very weak intellect. Defendant, who made a long rambling statement, was remanded.

"Industries."—This is the title of a new Manchester journal, a specimen copy of which we have now before us. The task which the proprietors of *Industries* have resolved to undertake is the establishment of a journal which shall commend itself to all classes connected with scientific and industrial pursuits. The object aimed at in carrying out this, is to bring before engineers, electricians, chemists, manufacturers, and all actively engaged in industrial occupations, the most recent practical applications of science, and the latest developments in the chief home and foreign industries. The electrical department will, we understand, be directed by Mr. Gisbert Kapp, and we congratulate the proprietors on having made such a capital choice. The paper is in colour a light greenish-blue with the letterpress and illustrations in indigo. We shall not be surprised if after a few issues, the first of which will appear on the 2nd July, a return will be made to black and white. The style of the articles generally, brings irresistibly to our mind an esteemed contemporary, the *Mechanical World*.

French Submarine Cable Works.—M. Granet, the Minister of Posts and Telegraphs, has just completed an inspection of the Government submarine cable works at La Seyne, near Toulon. The object of his visit was to arrange for the production at these works of the various materials comprised in submarine cables, such as conductors, gutta percha, compounds, &c., which hitherto have been brought from England. At present there are only two sheathing machines at La Seyne, one for light cables and the other for heavy types. The former can turn out 3,000 metres of deep sea type, and the latter 2,000 metres of intermediates and shore ends, per diem. The improvements and additions to these works are to be on a very large scale, and are evidently instigated in consequence of a scheme, now before the French Government, for placing France in closer connection with her colonies by means of submarine cables on a very extensive system. Meanwhile M. Granet has signed a concession for submarine telegraph cables which will place certain of the colonies in more direct communication with France. The cost of these cables is estimated at about 15 millions of francs. This concession will be submitted to the Chamber when Parliament next assembles.

Every Builder his own Electrician.—Mr. Edward Conry favoured us last week with a capital letter anent the article we published from the pen of Mr. Hamilton-Church. We trust that both the article in question and Mr. Conry's communication will meet the eye of many a builder and that some of the Transatlantic enterprise may be stirred within them. We cannot, however, do otherwise than agree with another correspondent, who takes Mr. Conry to task respecting the manufacture of the Planté form of secondary batteries.

The Royal Society.—The *conversazione* of the Royal Society was held on Wednesday evening. Some 600 to 700 guests were present, and amongst the exhibitors we noticed the names of Mr. Conrad Cooke and the Electrical Power Storage Company.

The Cable Conference.—The International Conference for the protection of submarine telegraphs held its first meeting at the Paris Foreign Office on Wednesday. It was opened by M. de Freycinet. Delegates attended from the Argentine Confederation, Austria-Hungary, Belgium, Brazil, Costa Rica, Denmark, the Dominican Republic, France, Great Britain, Greece, Guatemala, Italy, Japan, the Netherlands, Portugal, Roumania, Russia, San Salvador, Serbia, Spain, Sweden and Norway, Turkey, the United States, and Uruguay. A sub-committee was appointed to examine and report on the legislation required in different countries to give effect to the Convention of March 14th, 1884. It consists of Mr. Lamb, M. Orban, M. Renault, Mr. MacLane, and Senor Coromina. On the motion of Mr. MacLane, the United State Minister, seconded by Mr. Kennedy, it was agreed that the representatives of telegraph companies shall attend the sub-committee, and make their statements before it. They will accordingly go before the sub-committee to-morrow. Mr. Pender, the Marquis of Tweeddale, and others represent many of the companies. The conference is expected to meet again next Saturday or Monday, to receive the report of the sub-committee. The telegraph companies wish to make an amendment in the convention, to relieve them from certain costs imposed by it.

The British delegates are :—Mr. Kennedy, C.B., head of the Commercial Department of the Foreign Office ; Mr. Trevor, C.B., Assistant Secretary to the Board of Trade ; and Mr. Lamb, of the Secretary's Department of the Post Office. Mr. Farnall, of the Foreign Office, will be secretary to the British delegates.

Incandescent Lamp Patents.—The first portion of our report of the law suit now going on between the litigants in the matter of incandescent lamp patents will prove interesting reading. We shall endeavour to enter as fully into this matter as we have done in previous trials in which the telephone figured as the bone of contention.

Sale of Electrical Plant.—We would remind our readers that the effects of the Consolidated Electric Company, now in liquidation, will be sold by Messrs. Wheatley Kirk, Price and Goulty, on Wednesday and Thursday next, commencing each day at 11 o'clock prompt.

Electric Locomotion.—Mr. A. J. Jarman writes again as below :—"I presume the local newspaper referred to by your correspondent, Mr. Alfred Melhuish in the last issue of the ELECTRICAL REVIEW, containing a *detailed* account of the trial of the electric locomotive of the Electric Locomotive and Power Company was the *Leyton and Leytonstone Express and Independent*. I would say that upon making a search at Somerset House I find that the name of the registered proprietor of that paper and the name of the secretary of the above company is the same, the address being

the same in both cases, in all probability these reports should be taken *cum grano salis* until we have corrected reports certified by competent men."

Improvements in Telephones.—In our next issue we hope to be able to illustrate an improved telephonic receiver, designed by Mr. J. Ebel, who is already well-known to our readers in connection with submarine cable operations.

Dermatine.—A company is in course of formation to work the patents of Mr. Maximilian Zingler for the manufacture of dermatine, a substance said to be a substitute for gutta-percha, India-rubber, and leather. The prospectus states that "Insulated telegraph wires for underground work have been covered with it, and the results obtained warrant the anticipation that in this department alone a large business will be done by the company. The capacity of the material for standing high temperatures should make dermatine-covered wires especially safe and desirable for electric light leads. Specimens of wire, of a pattern suitable for underground work, have been proved to possess an insulation of over 1,000 megohms per knot after prolonged immersion in water ; it is therefore confidently believed that the company will be able to supply to the public an equally efficient and far more durable insulated wire than any now in the market, and the prices being lower than those charged for India rubber or gutta percha, it is expected that Dermatine will, to a very great extent, eventually supersede the materials now used for this and many other electrical purposes." We should like to test some of this material.

NEW COMPANIES REGISTERED.

Woodhouse and Rawson Electric Contract and Maintenance Company, Limited.—Capital : £50,000 in £10 shares. Objects : To acquire the goodwill of the contract department of Messrs. Woodhouse and Rawson, of 11, Queen Victoria Street, and also the electric installation, contract and maintenance business of the Crossley Telephone Company, Limited, so far as the same respectively relate to Lancashire, Yorkshire, and Cheshire. Signatories (with 1 share each) : *F. L. Rawson, J. H. Ward, W. L. Madgen, 11, Queen Victoria Street ; *J. F. Harrison, Rawdon Hall, near Leeds ; *C. H. Priestley, Idle, near Bradford ; A. W. Lassen, Bradford ; J. Renwick, 58, Olinda Road, Stamford Hill, N. Directing qualification : 25 shares. Remuneration : £200 per annum. Mr. Otway Edward Woodhouse is appointed a director. Registered 6th inst. by Mr. Sydney Morse, of 5, Lime Street Square. Registered office, 19, Bolton Road, Bradford.

British and Colonial Dermatine Company, Limited.—Capital : 100,000 in £5 shares. Objects : To manufacture "Dermatine," a substitute for gutta percha, for insulating, waterproofing, &c., and for such purpose to acquire the assets and property of the Dermatine Syndicate, Limited, of 7, William Street, Camberwell. The purchase consideration is £40,000, payable in cash or in cash and paid up shares. Signatories (with 1 share each) : *Sir H. C. Mance, Bedford ; M. Zingler, 16, Fenchurch Street ; *W. W. Lander, 26, Throgmorton Street ; W. C. Watson, 7, Great Winchester Street ; *C. Kuypers, Leadenhall House ; J. S. Waterfield, 7, William Street, Camberwell ; J. J. Michael, 23, St. Quintin Avenue, North Kensington. Directing qualification : 50 shares. Remuneration : £100 per annum to each director. Mr. J. H. M. Batten is appointed a director. Mr. Maximilian Zingler is appointed chemical and technical superintendent for five years, at a salary of £400 per annum. Registered 8th inst. by Messrs. Crossley and Burn, 13, Moorgate Street.

Brilliant Incandescent Lamp Company, Limited.—Capital: £5,000 in £1 shares. Objects: To manufacture filament forming part of incandescent and other lamps, according to the process of G. Zanni. Signatories (with 1 share each): *G. Zanni (electrical engineer), 65, Gibson Square, N.; *R. Matthews, 21, City Road; *S. Baugh, 11, Canonbury Park North; D. Zanni, 59, Clouesley Square, N.; S. Tugman, 98, Junction Road, N.; J. Lea (electrical engineer), 75, Arlington Road, Camden Town; S. Matthews, 21, City Road. Qualification for directors, other than the first: 50 shares. The remuneration of the board will be appointed by the company in general meeting. Registered 8th inst. by Mr. D. E. Chandler, 45, Finsbury Pavement.

Alfred Slatter and Company, Limited.—Capital: £10,000 in £5 shares. Objects: To take over the business of electrical engineer carried on by Mr. Alfred Slatter, trading as Alfred Slatter & Co., at Leadenhall Chambers, St. Mary Axe. Signatories (with 1 share each), Edward Quick, C.E., Telford Avenue, Streatham Hill; Charles Major, 14, Prah Road, Finsbury Park; W. Wild, Leadenhall Chambers; A. L. Craig, 16, Woodvale, Forest Hill; J. S. Sledge (electrical engineer), 6, Mervan Road; F. W. Lewis, Metropolitan Chambers, New Broad Street. Mr. Alfred Slatter is appointed sole manager, at a salary of £250 per annum. Registered 11th inst. by Mr. Wm. Wild, Leadenhall Chambers.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Locomotive and Power Company, Limited.—An agreement dated the 22nd ult. and filed on the 8th inst. provides for the issue to Mr. Mark Bean, of Leytonstone, of 54 shares of £5 each in the capital of the company, to be considered as fully paid up when the sum of £3 6s. 8d. per share has been paid thereon.

Sir Coutts Lindsay and Company, Limited (Electricians).—The first annual return of this company made up to the 30th ult. was filed on the 5th inst. The original nominal capital of the company was £7,000 in £1 shares, but by special resolutions of the company in general meeting it has been increased to £30,000 in £1 shares. 20,000 shares have been taken up and £17,247 has been paid in respect thereof, and £2,753 remains unpaid. Registered office, 135, New Bond Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Brazilian Submarine Telegraph Company, Limited.

LORD MONCK presided on Wednesday at the 25th Ordinary General Meeting of this Company, held at Cannon Street Hotel. There was but a small attendance of Shareholders.

After the formalities of reading the convening circular and minutes,

The Chairman said: I am happy to say it will not be necessary to take up much of your time in recommending the resolution, that the report be adopted, for your consideration. The report, in fact, tells you almost everything I can tell you of the working of your system. You have observed from it that your property is all in good condition—good working order; your cables are working efficiently, and we have for the last half year, and I am happy to say up to this moment, enjoyed a good share of business, your expenses having been diminished, as compared with previous half-years, by some £6,000 or £7,000. These features constitute the favourable side of the picture. But I am sorry to say that you will also observe by the return given of the income of the Company that we are not in as flourishing a state, pecuniarily, as we have

been in the habit of being. Our income has diminished during the half-year which we are now considering, but there are causes in operation which we hope will cease, which will account for that. There has been an unhappy monotony in almost every meeting of a commercial character which one reads of, in which the Chairman is obliged to refer to the depressed state of trade for several years past. That still affects us. For some time it did not affect us—very curiously—for up to about a year ago our income was a growing one. But we now seem to have shared with other companies and enterprises of this kind, the effects of the depression of trade, and our income has been reduced. There is also another reason for the reduction, that is, the state of the exchanges between this country and Brazil. A great deal of our receipts, you are aware, are collected in Brazil, and, of course, are obliged to be transmitted home to England, and if the exchange is against us, of course we suffer in that way. The state of things is, however, improving. An improvement in the value of the Milreis has taken place, and has continued, I am happy to say. Therefore that cause will cease to affect our income to a certain extent. We also are suffering from a certain amount of competition on the part of the West Coast Company, which, of course, we cannot avoid. We must only meet it in the best way we can. We are engaged in negotiations which it would not be wise further to enter into, for consolidating and improving our position in Brazil, which will, to a great extent, get rid of difficulties of that kind. I do not think there is anything further in the accounts which calls for remark. You have them in your own hands, and I shall be glad to answer any questions. Meanwhile I move that the report and accounts to 31st December last be approved and adopted.

Sir Thomas Fairbairn seconded the resolution, which was adopted.

Mr. Griffiths, a shareholder, thought they had been fortunate in escaping the effects of the depression so long. He would ask whether during the last five months the falling off in the receipts had continued, and if so, if it would be likely to continue. He further asked for some information as to the meaning of the word Milreis; also what amount of debentures had been issued in respect of the West Coast Company. He had heard glowing anticipations of results described, but was not himself so sanguine. It would be satisfactory to hear a little more of their position in Brazil.

The Chairman replied: The "Milreis" is the unit of circulation in Brazil. We get our receipts from Brazil, in Milreis, and we have to turn them into £'s. sterling. That is the way in which the Exchange affects us. With regard to the West Coast Company, I think that question was fully debated at the extraordinary meeting held in January. Up to the present we have done nothing beyond proceeding with the construction of that line of telegraph, which is now being constructed; and, of course, we can tell nothing more than we have told as to the probable beneficial results. Those who are best qualified to judge, think it may be a profitable concern for us. All the traffic from that coast will, of course, pass over our lines, and any benefit derivable from it will come to us. With regard to the negotiations, I am afraid I must adopt the same formula often adopted in the House of Commons, and say that it would not be in the interests of the company that I should enter more largely into the matter. These negotiations are in progress, and I believe they will result in great advantage to this company. Beyond that I hope the meeting will not ask me to go on the present occasion. For the last 12 or 13 years the shareholders have trusted me and my colleagues with the management of their affairs, and I do not think they have had any reason to regret that confidence. As to the business during the last five months, it does not, I am sorry to say, show any recovery as yet.

Mr. Griffiths: I do not wish to ask any question that will hamper the directors, but what is the object of the negotiations in Brazil?

The Chairman: To consolidate and strengthen our position in Brazil.

Mr. Griffiths: But that is so very general. I must say I do not think the answers have been altogether satisfactory.

The Chairman: It is as far as I can go. Of course before any arrangement is concluded, it will have to come before the shareholders for their opinion.

Mr. Griffiths: But we as shareholders have a right even to look at the books if we choose. I think we ought to have a little more knowledge as to the future.

The Chairman: I have gone as far as I can go without violating my general duty to the shareholders generally, that of maintaining silence on a subject that should not be publicly known. (Hear, hear.) Therefore, I shall now put the resolution.

The resolution was then put and carried; as also was a vote of thanks to the chairman and directors.

Submarine Cables Trust.

ON Tuesday afternoon, at Winchester House, Old Broad Street, the 15th annual ordinary meeting of certificate holders was held under the presidency of Mr. John Pender. The report of the trustees (published in our last issue) was submitted.

The Chairman said the actual revenue of the Trust for the year ending April 15th, 1886, amounted to £18,838, as against £23,493 for 1885. The decrease of revenue, as explained in the report, had been caused entirely by the diminished dividends paid by the Anglo-American Company, in consequence of the Commercial Cable Company having forced the Atlantic companies to reduce

the tariff from 2s. to 1s. 8d. per word. As it requires £21,635 to cover our coupons and expenses, it is evident that but for the large balance brought into the accounts from the previous year, and the accidental circumstance of our having five quarterly dividends—through the Eastern Extension Company—to deal with, we should not have been able to pay our coupons in full. Practically, we began our last financial year with a balance of £4,937, and we carry forward £2,140. He hoped before they met again they would be working at remunerative rates, and be enabled to pay our coupons in full. He hoped that good sense would prevail, and that some alteration in the present tariff of the American Telegraph Company would be made, as he was sure the present rate could not be permanent, and would not pay. With these remarks he moved that the report of the trustees now submitted be approved.

Sir Daniel Gooch seconded the motion, which was put and carried unanimously.

The re-election of auditors, with remuneration of £25 each, was moved by Mr. Ford and adopted.

A vote of thanks to the chairman and to the co-trustees was agreed to, with an expression of the hope that the chairman's forebodings in reference to the dividends would not be realised.

The Chairman, in replying, said that the motive of himself and the trustees was, of course, to make money, and he trusted that sound business principles would prevail, and that they would be able to pay their coupons in full. They sincerely trusted that might be so.

The meeting then separated.

Great Northern Telegraph Company of Copenhagen.

At the general meeting of this company, held at Copenhagen on the 21st April, F. Zahle, Esq., presided.

The Chairman, C. F. Tietgen, Esq., addressed the meeting with regard to the general business of the company during the working year of 1885, and referring to the state of the company's cables said, that although the directors that evening would have the pleasure to report satisfactorily about the results of the year, there was not much to say under this heading. The usual interruptions of the cables, which could not be avoided, had again occurred; but having in themselves at no time been of an alarming nature, the repairs had, thanks to the efficiency of the company's two repairing steamers, the *H. C. Orsted* and the *Store Nordiske*, stationed respectively in Europe and in the far East, and thanks to the efforts of the company's excellent staff, been most speedily effected. During such interruptions the traffic of the company had in no way suffered, as the duplication system of the company had provided the means for supplying a ready outlet for the traffic which had originally been intended for the line interrupted for the time being. The only drawback of these repairs had been, as must always periodically occur, that the stock of spare cable used for repairs had to be replenished, and the company had therefore incurred an expense by ordering a new supply, the comparatively small cost of which had been included in the amount shown in the balance sheet as deducted from the reserve fund. The northern land line, passing through Siberia and connecting the company's European cable net with their lines in the far East, had in May, 1885, been interrupted for a fortnight, in consequence of inundations caused by the breaking up of the ice. These interruptions had in late years been very unusual, and the strenuous efforts which are being made to prevent such occurrences would guarantee against them in future. The traffic receipts had been highly satisfactory, and exceeded—theoretically, at least—the receipts in the prosperous year of 1884. Practically this excess, and more, even, had, however, unfortunately been absorbed by the loss of exchange on remittances. As the shareholders would be aware, the company collected their rates in the far East in Mexican dollars, and whilst ten years ago about 4s. 3d. could be remitted for a dollar, the company now barely received 3s. 4d. Considering that more than half a million of dollars was annually remitted in this manner, a heavy loss would therefore naturally result, and the large amount figuring on the debit side of the profit and loss account was thus explained. The great event of the year had been the International Telegraph Conference, which had been assembled at Berlin from the 10th August to the 17th September. Without entering into the details of different measures which had been laid before the conference, he would at once refer to the proposal of the German Administration with regard to the introduction of a uniform International Telegraph Tariff between any two countries within the limits of Europe—a project which had already been before the previous conference held in London in 1879. Although the measure did not pass in its entirety, the tendency of the original proposition had been so strong that in the result serious tariff reductions were adopted, and notably as regarded the telegraph correspondence between the more distant countries in Europe. It would naturally follow that in such circumstances our company, whose cables carry a very considerable part of the European and extra-European traffic, would have to be prepared to suffer a loss in consequence of the reductions passed at Berlin. To give examples: A message of 12 words (which our experience now showed us to be a fair average of messages transmitted over the company's lines) from Great Britain to Russia now costs 9s., whereas after the 1st July it would only cost 6s. 6d. The same with regard to China, for which country the rate from this country now is 5s. 4d. per word, whilst after the 1st July next it will only be 7s. 1d., and as the greatest proportion of these rates accrued to the company we would consequently have to bear the

greatest part of the proportion of the reductions. These reductions would, however, no doubt have the effect of gradually increasing the traffic, and thus, to a certain extent, compensate for the losses which the company would suffer. But, then again, such an increase of traffic would mean eventual increase of staff and of telegraph lines, and the company would therefore have to be prepared sooner or later to resort to the reserve fund. For this reason the directors had thought it right to propose once more to increase that fund in the same exceptional manner as in former years. In accordance with conventions concluded with Russia and Sweden, the company had already now obtained, free of any extra expense, a reserve line between St. Petersburg and Nystad, in Finland, and another in Sweden between Grislehamn and Gothenburg. These two lines would be connected by the cable which had been laid by the company between Sweden and Finland in 1883, and thus constitute a complete and direct line from St. Petersburg to Gothenburg, which would be of great advantage in the transmission of the traffic between Russia on the one side and Great Britain and France on the other side. At the same time, he would mention that the company was now going to introduce instruments with certain improvements, which, after a fair trial, had shown that by their employment greater speed of transmission could be ensured within the carrying capacity of the cables. The position of the company would thus be that they would be enabled to meet all requirements in case a considerable increase of the traffic resulted. But, unfortunately, the effect of the continued general stagnation of trade, industries, and navigation, which as regards the company's revenue is no longer counterbalanced by the effect of political and military movements in the far East, had already been felt in the amounts of the receipts as shown by the monthly traffic returns published since the beginning of this year. What with the falling off in earnings, and what with that which after the 1st July next would follow from the reduction of the rates, it could be foreseen that the company's future income, and particularly that of the present year, would be considerably lower than that of previous years. Thanks to the further addition to the reserve fund, and to several other measures taken during previous good years, it could, however, be hoped that the exceptional circumstances referred to would not tend to diminish the dividend hitherto paid to the shareholders in any sensible degree. The feverish activity which the political events had called forth some years ago with regard to the development of the telegraph net in the interior of China had somewhat abated after the conclusion of the peace between France and China. The fact, however, remained that the telegraph had become a positive necessity for the Chinese, and no fears need therefore be entertained that further developments would be arrested. During the year several lines had been established, of which one of the most important was that which connected Seoul, the capital of Corea, with the Chinese telegraph system. This line, which had been constructed by the company's engineers, of whom several had entered permanently into the Chinese service, would shortly be extended from Seoul to Fusan, the Japanese colony on the South Coast of Corea, the landing place of the cable connecting Corea with Japan proper, which the company had laid in 1883. The company's instrument workshop at Copenhagen had been well employed, and had latterly received important orders for instruments. The balance sheet, which had been in the hands of the shareholders for some time past, had shown that after all the general charges, as well as the ordinary charges for interest and amortisation of debentures, and the payment of the usual 5 per cent. interim dividend during the past year, had been provided for, there remained an amount of £133,699 13s. 6d., which the directors submitted to the meeting to deal with as follows:—£45,833 6s. 8d. to be divided amongst the shareholders as an extra dividend of three per cent. (making the dividend for the year, including the interims already paid, 8 per cent.); £2,777 15s. 7d. to be allotted to the pension fund for the staff; £55,555 11s. 1d. to be added to the reserve and renewal fund; and £29,533 0s. 2d. to be carried forward to next year's account.

Without discussion the propositions of the directors were unanimously adopted, the accounts were passed, and the usual discharge was given to the directors.

L. P. Holmblad, Esq., the retiring director, was unanimously re-elected.

A. Berner, Esq., and Aug. Garde, Esq., were likewise unanimously re-elected as shareholders' auditors.

The West India and Panama Telegraph Company, Limited.—We are informed that at a meeting of the directors held on Wednesday last, it was decided to place £2,000 to reserve, and to recommend to the shareholders at the approaching meeting that a dividend of 6s. per share be declared on account of arrears of dividend on the first preference shares.

Consolidated Construction and Maintenance Company, Limited.—The directors have resolved to recommend, subject to final audit, that a further dividend of 2½ per cent. be paid, making 5 per cent. for the year.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited: The receipts for the week ending May 7th were £1,760, after deducting the fifth of the gross receipts payable to the London Fintino-Brazilian Telegraph Company, Limited.

PROCEEDINGS OF SOCIETIES.

Royal Society, March 25th.

[ABSTRACT.]

"On the Changes produced by Magnetisation in the Length of Iron Wires under Tension." By SHELFORD BIDWELL, M.A., LL.B. Communicated by Prof. F. GUTHRIE, F.R.S.

In a paper communicated to the Royal Society about a year ago, the author discussed the results of certain experiments made by Joule in relation to the effects of magnetism upon the dimensions of iron and steel bars.

It is well known that the length of an iron rod is in general slightly increased by magnetisation. Joule enunciated the law that the elongation is proportional in a given bar to the square of the magnetic intensity, and that it ceases to increase after the iron is fully saturated. The author's experiments, made with a greater range of magnetising forces and with thinner rods than those used by Joule, showed that if the magnetising current were gradually increased after the so-called saturation point of the iron had been reached, the elongation, instead of remaining at a maximum, was diminished, until, when the current had attained a certain strength, the original length of the rod was unaltered, and if this strength were exceeded, actual retraction was produced.

Joule also found that when the experiment was performed upon an iron wire stretched by a weight, the magnetic extension was in all cases diminished, and if the weight were considerable, magnetisation caused retraction instead of elongation. From these facts he appears to have formed the conclusion that, under a certain critical tension (differing for different specimens of iron, but independent of the magnetising force), magnetisation would produce no effect whatever upon the dimensions of the wire. In one of his experiments a certain iron wire loaded with a weight of 408 lbs. was found to be slightly elongated when magnetised; the weight was then increased to 740 lbs., with the result that magnetisation was accompanied by a slight retraction. In both cases the magnetising currents varied over a considerable range, and the smaller ones were without any visible effect. Commenting upon these results, Joule conjectured that "with a tension of about 600 lbs. (which number is roughly the mean of 408 and 740) the effect on the dimensions of the wire would cease altogether in the limits of the electric currents employed in the above experiments."

In reference to this surmise the author in his paper of last year expressed his belief that, if Joule had actually made the experiment, he would have found that the length of the wire was increased by a weak current, that a current of medium strength would have had no effect whatever, and that one of his stronger currents would have caused the wire to retract. He had, in fact, reason to believe that the effect of tension was to diminish the "critical magnetising force" (which produces maximum elongation), so that the retraction which is found to occur in all iron rods when a sufficient magnetising force is employed, is observed with smaller magnetising currents when the rod is stretched than when it is free, but want of suitable apparatus prevented him from submitting this idea to the test of direct experiment.

He has lately modified the instrument, which was described in his former paper, in such a manner that it can be used for observing the effects of magnetisation upon rods and wires under traction, and the results of a series of experiments made with it are presented in a synoptical form in the subjoined table. Four specimens of iron were used. The first was a wire of commercial iron, 1.2 mm. in diameter, which had been softened by heating in a gas flame; the second was a strip of annealed charcoal iron, 5.5 mm. wide and 0.55 mm. thick, its sectional area being about 3 mm.; the third was a piece of hard unannealed wire, 2.6 mm. in diameter; and the last was a wire of very pure soft iron, 3.25 mm. in diameter, which had been carefully annealed. These were successively fixed in the apparatus, and loaded with

weights varying from 3 lbs. to 14 lbs. While under the influence of each load, four observations were made in the case of each wire:—(1) A determination was attempted of the smallest magnetising current which sensibly affected the length of the wire in the direction of elongation or retraction. (2) The current producing maximum elongation (if any) and the extent of such maximum elongation were found. (3) A determination was made of the critical current which was without effect upon the original length of the wire, i.e., the current of such strength that a weaker one would cause elongation and a stronger one retraction. (4) The retraction produced by a fixed current of 1.6 ampère was measured.

The figures recorded in the table disclose the following facts:—

(1) The effects produced by magnetisation upon the length of an iron wire stretched by a weight are in general of the same character as those which have been shown in the former paper to occur in the case of a free iron rod. Under the influence of a gradually increasing magnetising force such a wire is at first elongated (unless the load be very great), then it returns to its original length, and finally it contracts.

(2) The maximum elongation diminishes as the load increases according to a law which seems to vary with different qualities of iron. If the ratio of the weight to the sectional area of the wire exceeds a certain limit, the maximum elongation (if any) is so small that the instrument fails to detect it.

(3) The retraction due to a given magnetising force is greater with heavy than with light loads.

(4) Both maximum elongation and neutrality (i.e. absence of both elongation and retraction) occur with smaller magnetising currents when the load is heavy than when it is light; retraction, therefore, begins at an earlier stage. Thus the anticipation expressed in the author's former paper is justified.

(5) The phenomena, both of elongation and of retraction are, as might be expected, greater for thin than for thick wires, and for soft than for hard iron.

Physical Society, May 8th, 1886.

Prof. H. McLEOD, F.R.S., Vice-President, in the Chair.

Mr. W. A. PRICE was elected a member of the society. The following communications were read.

"On a Modified form of Wheatstone's Rheostat," by Mr. SHELFORD BIDWELL. A wire is coiled upon a non-conducting cylinder, as in the ordinary forms of rheostats, one end of the wire being in contact with the brass axle of the cylinder. A screw is cut upon the axle, the pitch being equal to the distance between the consecutive turns of the wire, and this, working in a fixed nut, causes the whole cylinder to travel in the direction of its axis. A fixed spring bears upon the wire at a convenient point, and by the travelling motion of the cylinder this point of contact remains fixed in space, and the effect of turning the cylinder is to introduce more or less resistance between the spring and the brass axle. Binding screws on the base of the instrument are in contact with the nut and the bearing spring. Though this arrangement has several obvious advantages over the usual forms, Mr. Bidwell does not recommend it in cases where it is required to introduce a known resistance, but where it is important to adjust a resistance to a nicety or to cause a continuous variation it is of great use.

Prof. PERRY, remarking upon the importance of being able to vary a resistance gradually, described an instrument he had used with advantage. A number of plates of gas carbon are placed between two parallel copper plates, one of which is fixed and the other adjustable by a screw; by applying pressure by means of the screw, the resistance between the plates can be varied uniformly and regularly from 2 to 10 ohms, beyond which point the increase is very rapid.

"On a Theorem Relating to Curved Diffraction Gratings," by Mr. WALTER BAILY. In a paper read before the society in January, 1883, the author showed that if a plane be taken perpen-

	Commercial iron wire, diam. 1.2 mm.				Charcoal iron strip, section 3 mm.				Hard wire, diam. 2.6 mm.		Soft wire, diam. 3.25 mm.	
	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	14 lbs.	3 lbs.	14 lbs.
Stretching load ...												
Smallest current producing sensible elongation ...	0.043	0.064	0.084	...	0.033	0.020	0.029	0.064	0.12	0.15	0.064	0.083
Current producing maximum elongation ...	0.49	0.39	0.23	...	0.44	0.33	0.27	0.15	0.70	0.58	0.70	0.58
Current by which original length is unaffected ...	0.99	0.73	0.47	0.23	1.30	0.99	0.77	0.53	0.99	0.94	1.24	1.09
Maximum elongation in scale divisions ...	2	1.5	0.5	...	10	6	4	1	2.5	2.5	6.5	4.5
Retraction with current of 1.6 ampère ...	6	9.5	11	11	9	15	18	20	11	11	8	11

The magnetic field at the centre of the coil = current $\times$ 92.
One scale division = one five-millionth part of the length of the wire.

dicular to the lines of a curved diffraction grating, and a normal to the grating be taken as the initial line, then the equation

$$\frac{\cos^2 \theta}{r} = \frac{\cos \theta}{c} + \frac{1}{d},$$

in which c is the radius of curvature of the grating, and d is an arbitrary constant, gives a curve having the property that if a point of light be placed anywhere upon it, the curve is the locus of the foci of all diffracted rays whether reflected or transmitted. In the present investigation d is supposed to be greater than c , which allows of the source of light being at infinity. The points where the curve given by the above equation cuts the normal are called the normal foci. There are two of these, one relating to the reflected and the other to the transmitted light, the grating being supposed to consist of a number of opaque lines in space. It is then shown that if the grating be supposed to turn about the line in it intersecting the initial line, the normal foci will trace out two parabolas whose common focus is the origin, and common latus rectum is equal to the diameter of curvature of the grating, the parabola for reflected light being convex to the source of light, and that for transmitted light, concave.

"On Some Thermo-dynamical Relations," part IV., by Prof. W. RAMSAY and Dr. SYDNEY YOUNG. The first part of this communication deals with Profs. Ayrton's and Perry's criticisms upon the previous papers by the authors upon this subject. In the second part a brief review is given by the various attempts that have been made to represent the pressure of a saturated vapour as a function of the temperature.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

4841. "A system of photo-telegraphy." W. GEMMILL. Dated April 20. 6d. The object of the system is to connect a selenium-celled circuit with a separately supplied one lighting an electric lamp so that when light or shadow falls on the selenium cell the light of the lamp flashes out or becomes more or less extinguished as the case may be, and further to vary the illumination of the lamp with the degree of light falling on the selenium, so as to make the lamp available for photo-telegraphy or the transmission of photo-telegrams or photautographs by the ordinary postal wires.

4993. "Improvements in the mode of and means for lighting houses and other structures by electricity." T. TAYLER SMITH. Dated April 22. 8d. Consists in the use of a cable, band or rope of any suitable flexible material and preferably of an ornamental appearance, enclosing within it suitably insulated electrical conductors, and fitted with concealed terminal sockets at regular or suitable intervals of say a foot, adapted to receive the terminals of detachable incandescent lamps or incandescent lamp supports.

5361. "An improved electro-medical apparatus." A. T. KING. Dated April 30. 8d. Relates to portable apparatus used for administering a current of electricity of any desired strength for medical purposes, and it has for its object an improved method of constructing and arranging the several parts of such apparatus by which great simplicity of adjustment and arrangement are attained, with fineness and evenness of the electric current produced, easy graduation of the power and strength of the current, and a wide range of character of the effects produced.

5379. "Improvements in operating electric railway trains or vehicles." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated May 1. 8d. Consists in changing the electro-dynamic motor which receives current from the line and propels the train, into a dynamo-electric generator receiving energy from the momentum of the train and giving current to the line, and under perfect control to vary the braking power.

5404. "Improvements in electrical train signalling apparatus." A. M. CLARK. (Communicated from abroad by E. J. J. de Baille-hache, of Paris.) Dated May 1. 11d. Relates to a system of automatic electric train signalling for railways and steam or other tramways whereby the train is caused to signal its whereabouts to the station. This is effected by insulating one or more sections of rail and connecting the same with a line wire, so that when the train passes over this insulated section, the circuit will be closed between the insulated and uninsulated rails by the wheels of the train.

5420. "A combined electric bell push and incandescent lamp holder and switch." C. K. FALKENSTEIN. Dated May 2. 8d. Consists, preferably, of an elongated pear-shaped holder or handle, made hollow to permit of the passage of the wires to the several terminals contained therein, and having at its lower, or pendent, end a lens of suitable configuration, and so placed as to permit of a small incandescent electric lamp being mounted in the handle in proper position having regard to the lens used. Near the upper end of the handle, or at any other convenient part of it, a suitable projection serves, when depressed to complete, by means of suitable contact pieces, the bell circuit, while the circuit of the lamp is completed as required by a similar projection and contact making devices or by partly rotating the lower, or any other convenient part of the handle, contact in the latter case being made in any well known manner.

5547. "Improvements in telegraph cables, chains or conductors for submarine and other purposes, and in means for connecting such cables, chains, or conductors together, and to movable objects." R. M. LOWNE. Dated May 5. 8d. The inventor employs a cable containing a core of any convenient number of insulated conductors; over this core he employs a sheathing of any convenient number of metallic wires laid around the core so as to form a twist which preferably should entirely cover the core; around this sheathing he fixes at intervals, preferably by solder, metallic bands formed preferably of wire; the object of the bands is to prevent the wire sheathing from untwisting and lengthening when the cable is subjected to strain. Where a cable or conductor is required to be attached to a movable object he employs a universal joint constructed in such a manner as to take all strain off the electrical conductor or conductors at the movable part or parts of the joint.

5847. "An improved adjustable pendant or support for electric lamps." A. E. JONES. Dated May 12. 8d. Consists of a tubular telescopic rod or support terminating below in a lamp or lamp socket, and above in a metal cup or hemisphere fitted within a metal case of hemispherical form open at the bottom and adapted to be secured by its upper part to the ceiling. The metal cup or hemisphere is provided with a central tubular stem extending above the level of its rim and terminating in an insulated metal button or head of rounded form or cup shape against which a piston or plunger of correspondingly rounded form, or it might be a link or thrust rod, is tightly pressed by a powerful spring mounted centrally within the case. The metal cup and the lower part of the case in which it is fitted constitute a ball and socket joint, the parts of which are so proportioned and so tightly forced together that the friction of contact is sufficient to hold the telescopic rod, extending from the metal cup, rigidly in any position to which it may be moved. The insulated button at the top of the central stem of the metal cup is connected by a wire with one terminal, and the cup itself is in electrical connection with the other terminal.

6088. "Improvements in galvanic batteries." E. B. BURR. Dated May 18. 8d. Consists in so arranging the cells that they shall be connected so as to allow the liquid to flow from a reservoir on the top of the battery through each cell into a similar reservoir at the bottom of the battery. These reservoirs are made to be interchangeable, so that when the one at the top of the battery has emptied itself it can be replaced by the one at the bottom which will then be full.

6305. "Improvements in electric guns." J. C. MEWBURN. (Communicated from abroad by the American Electric Arms and Ammunition Company, of New York.) Dated May 22. 11d. The generic feature of the present invention consists of a movable electrode working through or upon a movable part of the gun, which part is movable to permit the insertion of the cartridge, and acts as a breech block or stopper, or to support or lock the breech block, and the electrode moving with such part but having itself an independent movement relatively thereto in order to bring it into contact with the cartridge to close the circuit thereto and fire the gun.

6365. "Improvements in telegraphic apparatus." R. K. BOYLE. Dated May 23. 11d. Relates to telegraphic apparatus and is chiefly designed to provide for enabling two or more messages to be transmitted simultaneously, or approximately so, through the same line-wire by different operators working independently of each other and irrespective of the time or speed of transmission. The improved apparatus is so constructed that each message sent will be received clearly and distinctly by sounds or other signals; and the armature or recording part of the receiving instrument is not limited in its movement, but can nevertheless make the proper impression in its to-and-fro movement, it will therefore adjust itself according to the action of the varying conditions of the weather upon the electric current in the line-wire.

8040. "Improvements in the feed regulating mechanism of electric arc lamps." C. F. COOKE. Dated July 2. 8d. Consists essentially of a specially sensitive method of liberating the brake wheel of the lamp and so allowing the carbons to approach as soon as the arc grows appreciably longer than is normal.

8675. "Electric telephonic apparatus." W. BLENHEIM. Dated July 18. 8d. The receiving portion consists of a U shape piece of iron rod with a coil of wire wound on the centre portion only. Over this and extending to the ends of the rod is a secondary coil of fine wire, the ends of the U are brought near an iron armature fixed to the centre of a membrane. The transmitting portion consists of a piece of carbon or other material carried by a yielding support to allow of a piston like motion, fixed near its edge is two metal pins, these pins are connected by a metal bar, supported at its centre on a knife edge end of a lever, which is weighted at the opposite end to put pressure on the contact pins. A battery, the pins in transmitter, and primary coil forms one circuit, the outer or secondary coil is connected to the line.

11121. "Improvements in apparatus for supporting or carrying and connecting the wires of acoustic telephone circuits." G. L. ANDERS. Dated September 18. 8d. The inventor provides at each place where the wire is to be supported or its angle changed a light pulley having a groove in its periphery to receive the wire. Between the body of the pulley and its axis is placed a yielding material, preferably a piece of pure soft rubber tubing; the axis of the pulley is supported in a suitable carrier which in turn may be mounted upon a centre carried by a bracket or other suitable fixed support so that the pulley can be turned to suit any desired angle.

to the framework of the lamp, while a little within the pivots of this lever the lever itself carries, by means of pivots carried thereby, a spindle on which are mounted a pinion and a ratchet wheel, the two together not being able to rotate in one direction without driving round a spur wheel which is mounted on the same spindle. The rack or carbon carrier has teeth cut in that side which comes against the before-mentioned pinion, the rack and pinion being thus in gear. The before-mentioned spur wheel gears into a second pinion upon the axis carrying the second wheel of a train of wheels, the second axis being mounted on bearings carried by the fixed framework of the lamp.

13607. "Improvements in telephonic receivers and transmitters." C. A. GISBORNE. (Communicated from abroad by F. N. Gisborne, and D. H. Keeley, of Canada). Dated November 9. 8d. In receivers constructed according to this invention two or more magnets are arranged upon the opposite sides of a vibratory diaphragm, preferably of iron, in such manner that greatly increased vibrations of the diaphragm are obtainable by alternate currents of electricity flowing through small helices of wire encircling the respective and similar poles of the magnets. In transmitters constructed according to this invention gravity multiple microphonic contacts are so arranged that their movements are equal and simultaneous when agitated or compressed by the vibrations of the diaphragm against which they rest or with which they are connected.

14741. "An improved duplex cut-out for electric circuits." R. M. BAILY, Jun., and A. GRUNDY. Dated December 1. 8d. Consists of a combination of a hand switch and two cut-outs, one of which can be substituted for the other in case of damage.

15040. "An improved voltaic battery." S. W. MAQUAY. Dated December 8. 8d. The positive element is composed preferably of two parts of lead and ninety-eight parts of commercial zinc, and either cast into rods or plates, or rolled out and used in any convenient shape. When the plates or rods are formed in the shape intended to be used they are coated with mercury, and submitted to heat in an oven of about 100° Fahr., and again coated and again heated, until the mercury is intimately mixed with each particle of the alloy. For the negative element, any convenient one is used, such as carbon, platinum, &c., either in plates or any other form, but a portion of such plates or rods is dipped into liquid sulphur, so that one-eighth of the plate or rod be covered with a film of sulphur, or broken granules of the sulphur are placed in the cell along with the plates, in about the same proportion, that is to say, that the surface of the sulphur granules will be about one-eighth the surface of the plates. The solution used for the outer cells is one part of sulphuric acid of common strength to twenty parts of water, or a solution of common salt.

CORRESPONDENCE.

Secondary Battery Patents.

Would you kindly inform me through the medium of your important columns if you are able to state whether there is any such "blanket" patent in America relating to secondary batteries as there is supposed to exist in this country in relation to telephone transmitters. I have recently heard it contended by some interested persons that the Faure U.S.A. patent covers not only what is said to be a most important feature, viz., the mechanical spreading of the paste, but also such principles as to preclude the possibility of any like invention being successfully perfected or used without infringing it. And against this expressed opinion I am in possession of a written one from a late Commissioner of Patents in Washington, affirming that —'s patent and Faure's patent having been carefully examined by him, possess distinct features, and that the one is not an infringement of the other.

May 10th.

G. B.

[We can hardly answer our correspondent's query authoritatively, but we have no doubt that there are those amongst our readers who can do so. So far as the U.S.A. patents are concerned, we believe that Mr. Faure acknowledged at the outset the existence of secondary batteries prior to his invention. Therefore the fundamental idea of storing electrical energy being old, and means for that end having been devised and used, subsequent inventors could only improve on such means, unless an entirely new departure were made. A substantial difference from the first means employed is enough to warrant the grant of a second patent for the particular means. Faure invented "an electrode con-

sisting of a support, coated on one or more faces with an active layer of absorptive substance . . . capable of receiving and discharging electricity, as stated." The support mentioned is a leaden plate similar to the one invented and used by Planté. Upon this plate he placed the coating of absorptive material, such as described, and encased the plate in a sack or envelope of porous material.

Now if we imagine an inventor, Mr. X, taking a step forward and dispensing with such a plate altogether, and making the electrode entirely of absorptive material, then, although the two electrodes perform the same office, that of Mr. X, say, being the more efficient, there is no interference between the two, and, consequently, no infringement of Faure's patent in operating and using such a modification as that of Mr. X.

The only thing used in common by Mr. X and Faure is the absorptive or active material, and this we believe Faure does not claim specifically in the U.S.A. patent, probably because he did not consider himself entitled to it. We shall be glad to publish any trustworthy opinions on a matter which is becoming more and more important.—EDS. ELEC. REV.]

"An Unexplored Field in Electric Lighting."

Your correspondent, Mr. Edward Conry, in the course of his remarks under the above heading, suggests the employment of accumulators formed by the original Planté method. May I ask Mr. Conry if he has ever made a successful working battery by that process? My experience is that unless the lead plates have been previously prepared the process of reversing cannot be made to yield satisfactory results.

It is true that at first reversing does increase the capacity of a cell; but if continued beyond a certain point it will be found that the peroxide of lead will become detached from the plates, instead of being reduced to spongy lead.

It would be far safer to procure the cells from a responsible firm than to trust to the productions of country carpenters and plumbers.

At the same time, it would be interesting to know if unprepared or home made plates have ever been successfully employed.

R. F. Y.

May 11th, 1886.

Matters Telephonic in America.

As it may be possible that some of your numerous readers on your side of the great Atlantic ferry may take some little interest in matters telephonic of this side, I send you extracts from newspapers touching an investigation by a committee appointed by Congress regarding the allegations brought against the Attorney-General. This committee sits four or five hours every day, and its investigations have taken a range so wide that any person who has ever said "telephone" can appear before the committee and testify.

I send you the entire examination of the Attorney-General under oath, so that you may be able to confirm what I now write thereon, and that is, that not a shadow of even a suspicion of improper conduct rests upon the Attorney-General. His statements were confirmed by several other witnesses, whose evidence I also send you.

I send you the evidence of Mr. Forbes, President of the American Bell Company. He stated that the capital stock of companies licensed by his company was about \$50,000,000, of which his company held \$22,000,000. Last year the company paid a dividend of 16 per cent. on its capital, of which only \$3,000,000 was ever paid in cash to that company.

Prof. Bell testified that in 1874 he sold two-thirds of all his future inventions to G. G. Hubbard, whose daughter Bell subsequently married, and to a Mr.

Saunders; the terms of the sale were that these two were to contribute all of the monies necessary to further experimentation, and defray expenses of taking out patents and of litigation. Bell stated that when the American Bell Company was formed he received \$1,000,000 in shares of the company, and Hubbard and Saunders each a like amount. Bell transferred all his shares, save one, to his wife. Hubbard, Bell's father-in-law, testified that the amount he and Saunders paid out under the agreement with Bell was about \$60,000, so that for that sum he and Saunders received each \$1,000,000. One of the newspaper slips I enclose shows that some of our *free* and *independent* newspapers are not averse to receiving a little filthy lucre for their services.

The suit of the United States *v.* Bell and others will be called for trial about May 1st, and the counsel for Bell will demur to the jurisdiction of the Court, also to the right of the Government to institute such a suit—see extract enclosed.

I have read the judgment of Justice North in the case of the U. T. Co. *v.* Bassano and Slater, and it brought to my mind the wise judgments of Dogberry.

W. C. Barney.

McPherson House, Washington,
April 30th.

Sabine *v.* White.

I hope you will allow me to correct an error I made in my previous letter to you, and thereby do an act of justice to Mr. J. G. White in America.

In my previous letter I wrote as if the late Robert Sabine had preceded Mr. White in the same line of thought about the covering of electric wires, but in doing so, I have erred. Mr. Sabine made two tables for currents, from 5 to 90, and from 100 to a 1,000 amperes for conductors of bright copper exposed to the air. These tables were first published in the *ELECTRICAL REVIEW* of January 6th, 1883, and reprinted in the 5th of May number of the same year. At the end of the latter publication of the tables is appended this note: "When the conductor is covered with India-rubber, the rise of temperature will be about 25 per cent. less than the values indicated above." This note implies that to cover a wire, carrying a current of electricity, is a means whereby the wire may be kept cool, and as this result is in accordance with the results of Mr. White's experiments, I too readily adopted the conclusion, that Mr. Sabine had made experiments which led him to write the above note: but on a more careful examination of his published writings, I find that the note is a contradiction to all his other writings, and there is no evidence whatever in them to show that he had made experiments with covered and uncovered wires, such as Mr. White has made. That Mr. Sabine, prior to his making out the said tables, did not make experiments on covered and uncovered wires, is manifest from his own declaration, that the tables "are only tentative, and do not pretend to be strictly exact." In Mr. Sabine's paper, including the tables as first published on January 6th, 1883, he enters into theoretical statements about the effect of covering wires, and sums up his opinion in these words: "The elevation of the temperature of any [electric light] lead is proportional to the obstruction which the insulator offers to the escape of the heat generated in it." Now this opinion of Mr. Sabine is overturned and shown to be untrue by the results of Mr. White's new experiments, as published by Prof. Anthony in an American contemporary, and quoted on page 356 of this volume of the *ELECTRICAL REVIEW*.

James Johnstone.

8, Merchiston Park, Edinburgh,
May 10th, 1886.

[Mr. Johnstone might have spared us the trouble of again engaging him in a controversy. His previous letter, in so far as the late Robert Sabine is concerned, needs no correction. He *did* experiment on the subject

under discussion; we were enabled to obtain a full knowledge of his work during its progress, and to occasionally assist him; and the note and opinion to which our correspondent refers not only do *not* contradict, but *verify* his other writings.

The results of his labours in this direction are, we fear, like much other valuable matter, lost to the world; but the following extract from his paper of January 6th, 1883, will be sufficient to show anyone, Mr. Johnstone perhaps excepted, that Robert Sabine had studied the question of covered *v.* uncovered electric light conductors to some purpose.

"While at work, the tendency of all light leads is to get warmer. How much warmer depends upon a balance between two things, viz., the heat generated by the current, and the facility with which this heat can *escape into and through the insulating covering*. This heat is an item of waste which cannot be wholly avoided, although it may be reduced to a minimum. If the insulating covering were as efficient an insulator for heat as for electricity, no covered wire could escape becoming, in time, when in use, incandescent. But happily those materials which are chosen in practice for electrical insulators are, as a rule, *not good heat insulators*.

"Air and glass—two of the best electrical insulators—are *very indifferent heat insulators*. Vulcanite—an excellent electrical insulator—is, when thin, *highly diathermanous*. India-rubber—the material most generally used for insulating electric light leads—*stands only second in diathermancy to vulcanite—a property, by virtue of which the heat generated by the current, instead of being bottled up and accumulating to the detriment of the system, is easily passed through the insulating covering and liberated.*"

We have italicised portions of the above extract, for it is evident to us that notwithstanding Mr. Johnstone's careful examination of Sabine's writings, he must have overlooked these points, or perhaps he has made himself wilfully blind to them. In conclusion we have only to add that we must decline to publish anything further on this matter.—EDS. *ELEC. REV.*]

Incandescent Lamp Making.

Can any reader of the *ELECTRICAL REVIEW* inform me if the whole process of incandescent lamp making has ever been published; and if so, where and when?

Also which is the most reliable direct-reading voltmeter to use when the E.M.F. has to be measured about 150 times per day of 10 hours. The instrument cannot be kept on continuously, as it is required for taking the E.M.F. of lamps when measuring the C.P. in the photometer; and both Cardew's and Ayrton and Perry's voltmeters, I find, are not at all suitable.

In the former the needle does not return to zero quick enough for my purpose, and the latter requires tapping at each reading; and then, I find, it must be recalibrated too often for practical use.

Very Anxious.

Ozone and other GAS.

In common with every reader of your journal with whom we are acquainted, we for some time looked forward to the perusal of certain effusions appearing in your Correspondence columns as a weekly recreation. It has, however, been suggested that the wearing threadbare of the one or two comic ideas may possibly indicate that these fearful and wondrous "facts" and "proofs" (?) are to be looked at in a serious light. The bare possibility of such an idea has struck consternation into many a manly breast; and we feel constrained to ask whether it may not be advisable to label such matter in the business-like way of the German papers, "Humoristisch."

A. and B.

May 10th, 1886.

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